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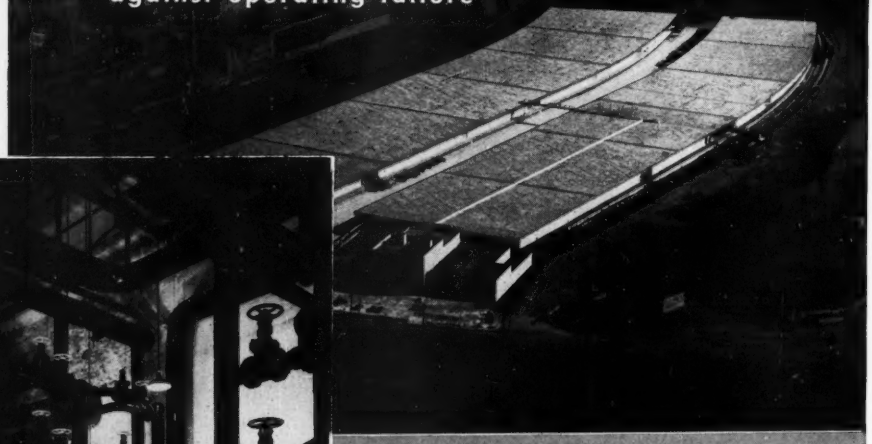

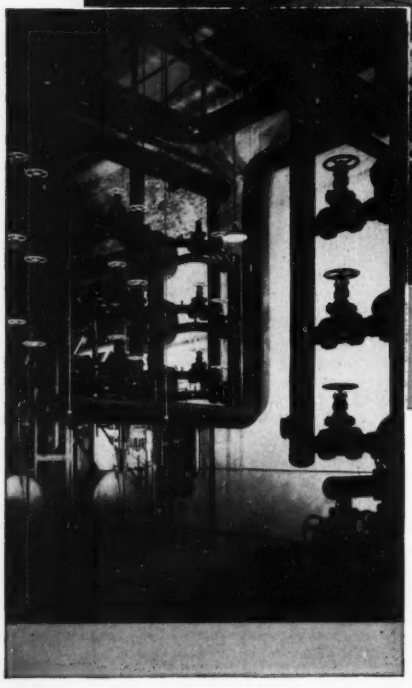

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FOR THINKING PEOPLE

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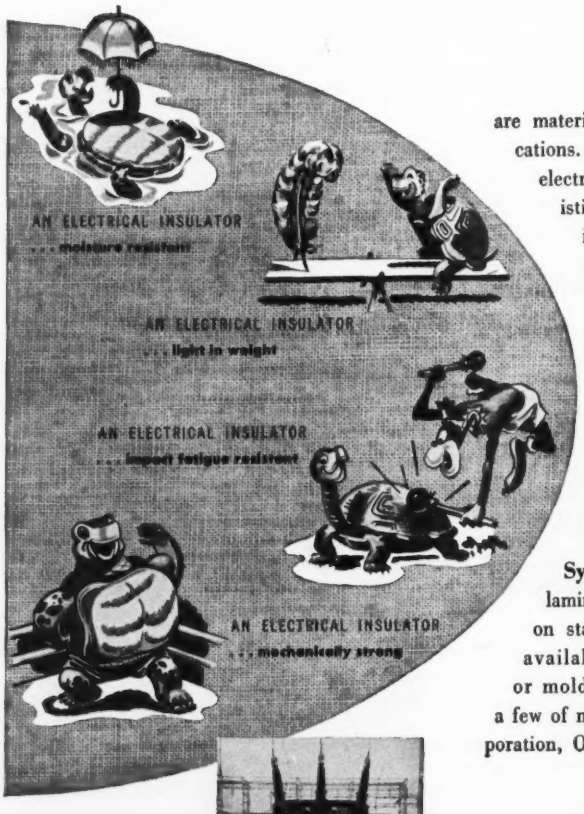
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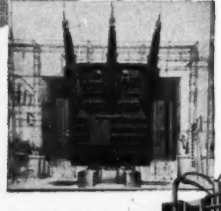

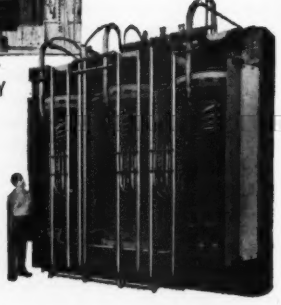

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Men and Electrons

By CHARLES W. WEST, EE '53

The story of man's relations with the electron must certainly extend far back beyond the dawn of recorded history. We can vividly imagine the respect with which our primitive predecessors viewed the crashing bolts of heavenly fire that were capable of felling the tallest trees. Yet, while these electrical phenomena were constantly in evidence, they were for ages interpreted merely as the celestial omens of various deities who were worshipped and feared. There was no such thing as true scientific inquiry in very early times. Actually, it has only been in the past one hundred fifty years that man has attained any degree of familiarity with the why's and wherefore's of this stuff called electricity.

Early Theorizers

Yet there was a host of early theorizers, some of whom were grossly in error, who played a very contributive role in the development of scientific thought in the field of electricity. In fact, it seems amazing today that these early pioneers, laboring in an environment steeped in ignorance and superstition, were able to formulate hypotheses which follow surprisingly the proven facts which are available to us today.

Telemeter receiving antenna used to record the flight of V-2 rockets.
—Courtesy General Electric

History tells us that over six hundred years before the dawn of the Christian era, Thales of Miletius, a brilliant Grecian philosopher and mathematician, noted that certain substances had peculiar attractive qualities. The ability of a chunk of amber which had been rubbed with silk to attract small particles of straw or feathers to its surface led Thales to the conclusion that a "soul" or "spirit" entered the amber as a result of the rubbing. This interpretation is typical of the way in which early men attached spiritual implications to any natural occurrence which they could not immediately explain. While his theory seems ridiculous today, it did instigate the beginnings of inquiry into the causes of electrostatic phenomena. Consequently, Thales has been called the "Patriarch of Electricians," which title, chronologically at least, he certainly deserves.

The Middle Ages

Over two thousand years passed and little progress was made in the field of electricity. This was due, in great measure, to the fables of magic and witchcraft which were prevalent during the Middle Ages. In the Sixteenth Century, however, William Gilbert, an Englishman, made an appeal to the rational thinking of the learned men of his time. Discarding the then prevalent ideas of fantasy and legend, he proposed the "radical" suggestion that all electric phenomena had causes based on natural science. He was the first to notice that attractive properties were not confined to amber alone; but that some other substances, too, had this strange property when "frictionized," as he called it. Subsequently, he classified

—Courtesy Westinghouse

Modern electronic scientists exhibit the same insatiable curiosity which set the ancient philosophers wondering about electric phenomena.

substances as "electrics" or "non-electrics," according to whether or not they became attractive when frictionized. Thus glass, sealing wax, and diamond were electrics; while ivory, flint, marble, emerald, and the metals were non-electrics. Besides his experiments with what we

(*Continued on page* 28)

COMPARISON WITH
FOUR-YEAR CURRICULA

Value of The Five-Year Program

By PROFESSOR HOWARD M. GIFFT

The present period is an important one in the development of Engineering at Cornell. The post-war inflation of college enrollments throughout the country is very definitely over, the last of the "four-year" Cornell Engineering students have graduated, and the first class taking the new five-year curriculum has started on the final year of a broader and deeper program than has been followed by any previous class at Cornell. It would be most surprising if this "guinea pig" group did not have some questions or misgivings as they see classmates graduating into a job situation that has been getting progressively less rosy during the past two years. What is the future for them? Will they be able to get jobs when they graduate? How will they stack up against graduates of four-year institutions? Most important, how will their training influence their careers ten or twenty years after graduation?

Some of these questions, of course, cannot be answered with documentary proof at this time. An examination, however, of the five-year curriculum and a comparison of it with the old Cornell four-year program and with curricula in other leading Engineering Colleges will give certain facts from which conclusions may be drawn. Such a study of Civil Engineering curricula has been made and, in all probability, similar studies of other branches of engineering would yield comparable results.

As a means of correlating subjects in the twelve curricula examined, five basic classifications have been made. The first group, called the Sciences, includes Mathematics, Physics, Chemistry, Geology and other Sciences. The second group, called Engineering, include all of the technical Civil Engineering subjects plus Mechanics, Materials, Electrical and Mechanical Engineering. The third group, called Business-Managerial, includes such courses as Contracts and Specifications, Law, Accounting, Public Administration, Industrial Management, Economics of Engineering, etc. The fourth group, called Humanistic-Social, includes such subjects as Economics, English, Speech, History, Languages, Sociology, Psychology and the like. The last group is the Free Electives over which the student has practically complete control of the subject matter included.

A summary comparison of the old and new Cornell curricula is given in Table I.

Sciences. The changes have been to add Differential Equations, Organic and Physical Chemistry, Microbiology, and a more thorough coverage of Physics.

Engineering. The coverage of Hydraulics, Structures, Transportation, Electrical and Mechanical Engineering, has been increased by

THE AUTHOR

Professor Howard M. Gifft

After graduating from Iowa State College in 1932 with a B.S. degree, Professor Gifft spent the next eight years in practical civil engineering work. He was associated in various capacities with the Iowa Highway Commission, the U.S. Forest Service, and the Iowa Conservation Commission. Following two years as project engineer and chief supervisor for the Conservation Commission, he returned to Iowa State College as an instructor, while working for his M.S. which he received in 1941. Coming to Cornell in 1941 as an assistant professor, he is now a professor and head of the department of sanitary engineering.

Professor Gifft's professional affiliations include the American Society of Civil Engineers, the Water Works Association, and the New York State Sewage Works Association.

sixteen credit hours. On the other hand, a reduction of fifteen hours was made from Surveying, Drawing, Engineering Problems, Introductory Lectures, and Civil Engineering Electives.

Business-Managerial. An increase of six hours includes Public Administration and Accounting.

Humanistic-Social. An increase of eighteen hours includes History, English, Economics, and Psychology. Two hours in Hygiene were deleted.

Free Electives. The four-year program included a total of fifteen elective hours, six of which had to be in Civil Engineering. The other nine were not completely free, however, as they were limited to advanced courses not open to Freshmen. This practically eliminated electing courses in Biology, Sociology, Languages, Fine Arts and History. The former nine hours of "semi-free" electives has been increased to twelve with practically no restrictions.

TABLE I

Classification of Subject Material in Cornell Civil Engineering Curriculum

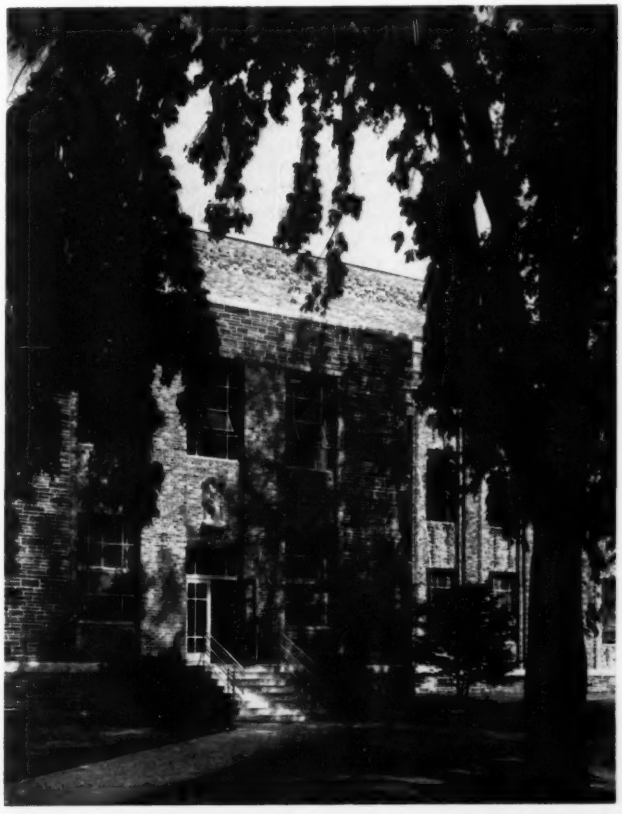
Subjects	*Pre-War 4-Yr. Curriculum*	*Present 5-Yr. Curriculum*
Sciences	29	40
Engineering	93	94
Business-Managerial	6	12
Humanistic-Social	11	27
Free Electives	9*	12
Total Credit Hours	148	185

*Limited to advanced courses not open to Freshmen.

The overall new curriculum, therefore, shows a material strengthening in the Basic Sciences, a further strengthening in the technical Engineering subjects without increasing the number of credit hours in these areas, a doubling of the Business-Managerial group, almost three times the former hours of required Humanistic-Social courses, and both an increased amount and a more liberal interpretation of the "free" electives.

In order to evaluate the competition offered by other engineering colleges, a comparison was made of Civil Engineering curricula from the ten largest four-year schools with the five-year program at Cornell. Recent catalogs of each school were carefully examined and from the descriptive material contained the individual courses were classified into various categories of subject material as shown on the accompanying chart. Most of the schools offer some form of specialization either by technical electives, or more usually, by an option. In such cases the courses required of all students were classified according to the categories adopted and the remaining required credit hours in the specialized subjects placed in the category of "General Engineering-Engineering Electives." It should be noted that in many cases these electives will be subjects classified as "Business-Managerial" with a consequent decrease in the Technical Engineering coverage.

Some difficulty was encountered in deciding whether certain courses should be classified in "Business-Managerial" or "Humanistic- Social." Such courses were relatively few and any errors would be compensating. Another problem had to do with electives. Several catalogs did not state clearly if certain electives were required to be technical or non-technical, or if the student had a completely free choice. It is possible that the average of these credit hours designated as "Free Electives" should be reduced slight-



Cornell Engineering keeps pace with the times, not only with modern buildings like Olin Hall (above), but also with a modern curriculum tailored to fit industry's needs.

ly and other categories increased by that amount.

Algebra and Trigonometry are not included in the Cornell curriculum; neither are they included by two of the schools studied. For this reason credit hours in these fields are not included in the compilation. Since Cornell gives no academic credit for Military Science and Physical Training, credit hours in these subjects were also eliminated in the study.

The average number of credit hours in each category offered by the ten schools and by Cornell are tabulated in the chart. The top number refers to that average and the lower number refers to Cornell.

A comparison of the curricula in a broad sense shows that the Cornell program includes a greater number of semester hours in the Sciences, forty to thirty-three, more in Engineering, ninety-four to seventy-nine, over twice as much Business-Managerial, twelve to five, more in the Humanistic-Social group, twenty-seven to fifteen, and a much greater freedom with respect to unrestricted electives, twelve to three. Classified according to technical and non-technical subject matter, the Cornell graduate will have between 140 and 152 hours of technical subjects and between thirty-three and forty-five non-technical hours, depending on his choice of electives. The other curricula indicate between 112 and 115 hours of tehcnical and twenty to twenty-three hours of non-technical work. The total coverage by Cornell, 185 hours, is fifty greater than the average of the other curricula.

Greater Coverage

A detailed examination of individual course coverages shows that in practically every category the Cornell program is more complete and in a number of categories has twice the average semester hours found in other schools' curricula.

On a year to year basis the Cornell student is at all times up to or beyond the four-year student in both technical and non-technical education. For example, at the end of the first year he has completed his six credit hours in Drawing, and has had five hours of Surveying, six hours of "freshman" Chemistry, six hours of Analytical Geometry and Calculus, six hours of Physics and six hours of English. Students from most of the other schools have also completed their Drawing and Chemistry and taken six hours of non-technical work. Only two schools, however, offer any Calculus and the others give only analytical geometry in the last part of the year. Very few schools offer any instruction in either Physics or Surveying during the first year, although four schools hold a survey camp during the following summer. On a total hour basis, at the end of the second year at Cornell a student has completed his Calculus, Physics, "freshman" Chemistry, Drawing, Statics and Dynamics. He has also had four hours of Organic and Physical Chemistry, three hours of Strength of Materials, and twelve hours of non-technical work. Students from most of the other schools have also completed their Calculus, Physics, Chemistry, Drawing, and Statics, and have had about the same covering in Surveying. Less than half, however, have completed Dynamics and only two schools give any Strength of Materials in the second year. On a total hour basis, at the end of the second year the Cornell student has had fifty-seven hours of technical and twelve hours of non-technical work, while the others have had, respectively, about fifty-four and nine hours, more or less.

During the third and fourth years there are greater differences between the Cornell and other curricula, due to the difference in years remaining before graduation. On a total hour basis, at the end of the third year the Cornell student has had ninety-two hours of technical and eighteen hours of non-technical work, while the others have had about eighty-seven and fourteen hours, more or less. At the end of the fourth year the technical and non-technical hours completed are 124 and 25 for Cornell and 115 and 20, each more or less, for the others.

It is interesting to note, incidentally, that the only courses in the Cornell fifth year which are normally but not always included in a four-year curriculum are Statically Indeterminate Structures and Foundations.

Another interesting fact has to do with the opportunity for specialization in the Cornell program if the student wishes to take all the "Free Electives" in one particular area. In Structure, Hydraulics or Sanitary Engineering it is possible for a student to acquire approximately twenty hours of advanced work beyond that normally required in a four-year curriculum. If these twenty hours are considered as Major work, and the required extra hours of technical work in other fields are accepted as equivalent to Minor work, a Cornell B.C.E. will be equal to a Master's degree from many four-year schools. It should be noted, that such specialization is not at the expense of any of the sciences or other engineering courses as necessarily is the case in the four-year "option" program.

Broader Foundation

According to the College of Engineering Announcement, "In his studies the Cornell Engineer builds a broad foundation of fundamentals in the basic sciences, in basic engineering application, and in modern technology . . . avoiding the limitations imposed on future development by narrow specialization. The further development of this kind of background is supported by the inclusion of a solid core of liberal, general and managerial studies throughout the period of his technical studies." It is evident from the foregoing study that these "foundations" are both broader and deeper at Cornell and are supported by a more thorough "core" of general studies.

As to the questions originally presented, unfortunately the first two concerning the future and the job possibilities after graduation can be answered only by the passage of time. The second two questions, however, may be different. How will Cornell men stack up against graduates of four-year institutions? How will their training influence their careers ten or twenty years after graduation? Again, the passage of time is the only absolute proof but as "coming events cast their shadows before," there should be no concern as to what the answers will be.

Rise of Diesel Power

By PROFESSOR E. B. WATSON

The Golden Anniversary of the diesel engine in America was celebrated in 1948. From its humble beginning in September, 1898, when the first engine produced by the American Diesel Engine Company was installed in the Anheuser-Busch brewery in St. Louis, has sprung a great industry whose product is of prime importance to the economy of the United States. In the decade from 1935-1945, installed diesel horsepower increased from 5 to 45 million. Conservative estimates indicate an annual production of approximately 10 million horsepower during the next ten years.

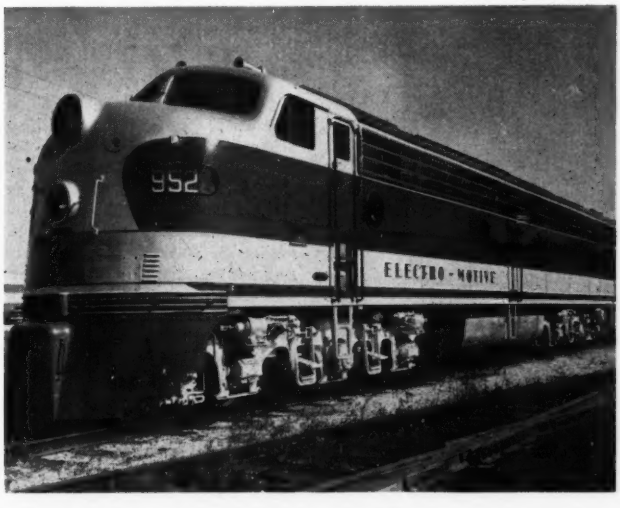
Diesel Applications

Throughout the nation the modern diesel locomotive is a familiar sight. Truly spectacular is the increase in diesel motive power on American railroads. In 1941 only 0.2 per cent of the total gross-ton miles of freight was handled by diesel locomotives; by 1948 this had increased to 21.3 per cent, while an even greater percentage increase occurred in passenger-car miles handled by diesels. Class I railroads during the first eight months of 1949 added 1249 new diesel-electric locomotives as compared with 41 steam. Complete dieselization of motive power has been achieved by several small roads, and steam locomotives will disappear from several of the largest as soon as current locomotive replacement programs are completed.

Not so striking, perhaps, but of equal importance is the growth of diesel utilization in other fields. Increased use of diesel-powered buses, trucks, and farm equipment is pronounced. The expansion of the Rural Electrification Program to bring electricity to areas not now served by public utilities has required additional diesel generating equipment. In 1948 over 900 communities received electrical energy from diesel power plants. Installation of diesel engines for propulsion of new marine vessels of many types is proceeding at a rapid pace, while many older ships are being converted to diesel power. Only recently announcement was made of the christening of the diesel-electric tug *Cornell*, one of a fleet being acquired by the Lehigh Valley Railroad for service in New York harbor.

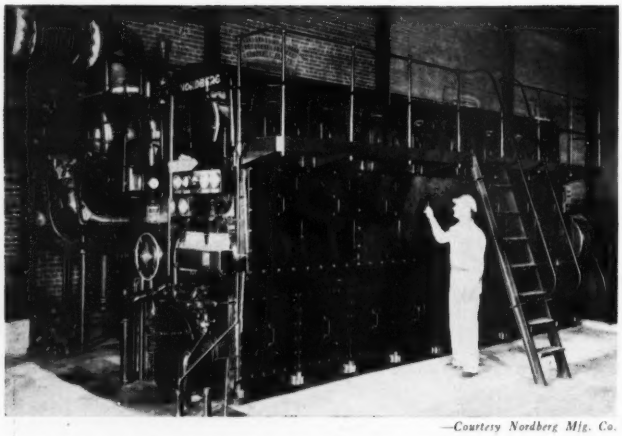
Sleek, efficient diesel-electric locomotives have all but replaced steam power on most railroads.

—Courtesy General Motors



Early Development

The widespread interest in the diesel for these, and numerous other



—Courtesy Nordberg Mfg. Co.

Diesel-powered central stations such as this provide much of the power for the nations smaller cities.

applications, results from its ability to provide dependable power at a lower cost than competitive power plants. The cost of power production is determined by several complex factors, including (1) first cost of the installation, (2) maintenance costs, and (3) fuel costs. Total fuel costs are determined by the thermal efficiency of the prime mover as well as by unit cost of the fuel. From its earliest days, the diesel engine has been characterized by a high thermal efficiency, not only at rated power but at part load. Credit must be given to Rudolph Diesel for this characteristic. His was the idea of compression-ignition of the fuel by the air temperature attained through the use of high compression ratios, for he fully appreciated the relationship existing between thermal efficiency and initial compression of the working medium. The soundness of his idea was proven in 1897, when his third experimental engine ran for seventeen days without interruption, and attained a brake thermal efficiency of 26 per cent. As a result of refinements in engine design, current diesel engines of certain types commonly show thermal efficiencies of 35-38 per cent, values not yet achieved by any competitive device.

The diesel engine was brought to America by Colonel Adolphous Busch, who, in 1897, acquired the American patent rights and formed the American Diesel Engine Company to exploit this new type of engine. In 1911, this company became the Busch-Sulzer Brothers Diesel Engine Company, now a division of the Nordberg Manufacturing Company—a concern which builds the largest diesel engines (up to 10,000 HP) in this country. Upon the expiration of patent rights in 1912, a number of companies undertook the manufacture of diesel engines, some of original design and some of European design, built under license. Engines produced during the period from 1912-1920 were large, heavy, low-speed units suitable only for stationary power generation or propulsion of large vessels. These engines, however, convincingly demonstrated the economy of diesel operation and proved it to be a reliable and dependable power plant.

Rapid Improvement

The period from 1920-1935 was one of remarkable progress in engine development. This was an era during which the suitability of the diesel engine for automotive and locomotive propulsion was demonstrated, and during which the medium and high speed engines of today were initially conceived. Of greatest import in permitting the development of smaller, lighter engines was the rejection of the air-injection type fuel system in favor of solid or mechanical fuel injection. Relieved of the need for a high pressure (100 psi) air compressor to provide injection air for blowing the fuel into the cylinder, new possibilities were opened for development of transportation type engines of minimum weight and size.

As early as 1924 diesel engines, built by the Ingersoll-Rand Company, were installed in switching locomotives, many of which are still in daily service. These engines, with a rotative speed of 600 rpm, a pis-

THE AUTHOR

Professor E. B. Watson

Professor Watson has been a member of the faculty of the Sibley School since 1940 except for 1946-1947 when he served as Technical Advisor to the Sales Manager of the Kendall Refining Company. He obtained his undergraduate training at the University of Rochester and the Master's degree from Cornell. During the war he served on the staff of the Naval Diesel Program conducted by the College of Engineering. Now a member of the Heat-Power Department, his major activity is in the field of combustion engines.

ton speed of 1200 feet per minute, a weight per horsepower of 50 pounds, a mechanical fuel-injection system, and the Price (a Cornell-trained engineer) combustion system, departed significantly from existing designs. In 1935, the first streamlined passenger trains powered by diesel locomotives went into service. Quickly capturing the public's imagination, these trains made records for speed, economy, reliability, comfort, and earning power that were prophetic of the new era in railroad motive power to follow.

During this period, automotive type diesel engines were developed with sufficiently low weight per horsepower to compete with gasoline engines for bus and truck application. Lower fuel consumptions, particularly at part load, and ability to consume low-cost fuels brought about their gradual acceptance, despite the handicap of higher first cost and the lack of trained personnel to service them.

At the outbreak of World War II the industry was ready with engine designs to satisfy the most exacting demands of the military. Engines of all types were required: small high-speed units for tanks, portable power plants, construction equipment, etc.; moderate-speed high output units for propulsion of submarines, destroyer escorts, and landing craft; and large-horsepower, low-speed engines for propulsion of tankers, merchant vessels, etc. The tremendous expansion of the industry to meet military demands is a matter of history. In excess of 35 million horsepower was supplied to the Navy alone, and, for the first time in Naval history, installed diesel horsepower exceeded steam power.

Engine Characteristics

Modern applications of the diesel engines no matter what the field, demand the following engine characteristics: (1) minimum weight per horsepower, (2) maximum horsepower per square foot of area occupied, (3) minimum fuel consumption at all loads and speeds, (4) maximum reliability, and (5) minimum initial and operating costs. Table I shows the principal characteristics of some typical modern engines classified according to primary fields of application, and indicates the diversity of methods currently employed to attain the above objectives.

Recourse to the fundamental relationship for the horsepower output of an engine of given displacement indicates the dependence of its maximum horsepower upon speed, brake mean effective pressure, and cycle type. The increase in specific outputs (higher horsepower per cubic inch of displacement and lower weight per horsepower) has been obtained by considerations relating to these factors.

Interest in the two-stroke cycle principle for the diesel engine was evidenced during the earliest stages of its development. The theoretical possibility of obtaining twice the power from a two-stroke engine of same displacement and speed as a four-stroke engine intrigued engineers then, as now. Because of problems such as scavenging difficulties, and piston, cylinder head, and injection valve cooling difficulties, early two-stroke engines did not realize the full potentiality of the cycle. In spite of these problems, however, the majority of engines of high horsepower (2000 and above) have generally been of this type.

Extensive development work on the two-stroke engine has resulted in solutions to many of its most perplexing problems, and Table I shows the extent to which it is employed today. The "ported" type

TABLE 1

PRINCIPAL CHARACTERISTICS OF SOME MODERN DIESEL ENGINES

Type of service	Engine type	No of cylinders	Bore & stroke	Rated HP	Rated RPM	BMEP at rated HP	Piston speed, ft/min	HP/in 3 displ.	Lbs/HP
Automotive truck & bus)	2-stroke	6	4¼"x5"	200	2000	93	1667	0.469	8.25
	4-stroke	6	5⅛"x6"	200	2100	102	2100	0.269	12.5
	4-stroke superch'g'd.	6	5⅛"x6"	275	2100	140	2100	0.369	10.3
Tractor & earth-moving equipment	4-stroke	6	5¾"x8"	150	1000	96	1333	0.121	37.5
Locomotive (main line passenger & freight)	2-stroke V-type uniflow	16	8½"x10"	1500	800	82	1333	0.178	19.3
	2-stroke opposed-piston	10	8⅛"x10"	2000	800	96	1333	0.192	—
Stationary power & marine	4-stroke	6	16"x20"	825	360	75.5	1200	0.034	94.5
	2-stroke ported, radial, separate blower	11	14"x16"	1800* *less blower power	400	65.7	1067	0.067	38.7
Aircraft (Junkers "Jumo")	2-stroke opposed-piston	6	4⅛"x6¼"	600 (T.O.) 450 (Cr.)	2200 2000	107 88	2310 2100	0.593 0.445	1.9 2.53

with intake and exhaust ports and with either crankcase compression of scavenging air, or air delivery from a scavenging cylinder or blower, is suited only for low and moderate speed engines for industrial and marine use where minimum specific weights are not essential. The "uniflow" types, either of the opposed-piston arrangement or with intake ports and exhaust valves are suitable for moderate and high speed engines where maximum brake mean effective pressures are essential. Scavenging air is furnished either by a positive displacement blower or a centrifugal compressor mechancially driven by the engine. Continued development of the two-stroke engine for applications requiring high specific outputs may be expected.

The perfection of high speed diesel engines has required the solution of many problems related to engine cooling, lubrication, and, in particular, to fuel injection and combustion. The magnitude of the injection and combustion problem is appreciated when one recalls that, in an engine operating at 1800 rpm, less than 0.01 second is available per cycle for the consummation of the injection and combustion processes. If incomplete combustion is allowed to prevail in the cylinder, high fuel consumption accompanied by a smoky exhaust may be expected. To compensate for the insufficient time avaliable in the high-speed engine in which to accomplish complete mixing, excess air is required to an extent determined by the provisions provided to assist in rapid, efficient fuel-air mixing. To increase air utilization, thereby achieving high mean effective pressures, attention must be given to the injection system and to the combustion chamber. Modern combustion chambers promote mixing by providing a controlled air movement. A variety of types has been developed for small-bore high-speed engines. For engines of moderate and large bore the use of the open chamber is, with few exceptions, standard practice, although this type chamber has not been widely used by American manufacturers of automotive engines until comparatively recently.

Supercharging

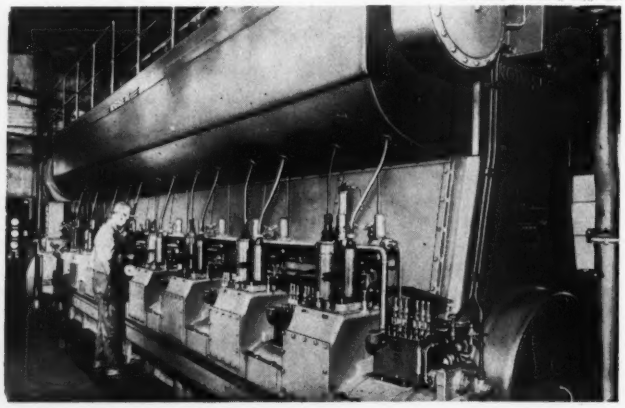
Since the weight of air inducted per cycle places a limit upon the mean effective pressure attainable in a cylinder, the output of a four-stroke engine may be increased if a means of inducting more air than can be inducted by natural aspiration is devised. Supercharging (the delivery of air to the cylinder at a pressure above atmospheric) can be effectively utilized to increase the weight of air with which the cylinder is charged. The addition of a supercharger, combined with proper valve timing (increased valve overlap, i.e., both intake and exhaust valves opened together at TDC) to obtain internal cooling and more complete scavenging of the cylinder, may permit a 50 per cent increase in engine output. This significant increase in output is generally realized without a comparable increase in cost, with only minor increases in engine weight and size, and frequently is accompanied by a reduction in specific fuel consumption.

Unlike the effect in the gasoline engine, diesel supercharging moderates, rather than intensifies, combustion problems due to detonation, thus making unnecessary any change in fuel quality. The increase of specific outputs of supercharged four-stroke engines to the level of highly developed two-stroke engines has intensified interest in the process. It is estimated that approximately 50 percent of the four-stroke engines sold today are of the supercharged variety.

Superchargers for engines of 500 horsepower or less are generally of the positive-displacement mechanically-driven type, for reasons of economy and because of their favorable delivery characteristics. For engines of over 500 horsepower the exhaust gas turbine-centrifugal blower combination has been widely used. Utilizing energy in the exhaust products, the turbine drives a centrifugal blower supplying air to the intake manifold. Until very recently supercharge pressures have been low, averaging 5-10 pounds per square inch above atmospheric. Several locomotive engines, however, are now using manifold pressures of 10-20 pounds per square inch; and a trend to still higher pressures may be expected. Turbine inlet temperatures are held below 1000°F. to insure long life.

"Dualfuel" engine burns gas, fuel oil, or a mixture of both.

—Courtesy Nordberg Mfg. Co.



Dual-Fuel Engines

One of the factors, as indicated earlier, which contributed to the expansion of diesel utilization was the low cost of suitable fuels. Recent changes in the price structure of petroleum products have worked to the disadvantage of the diesel engine. For this reason attention is currently directed toward the employment of fuels costing less than conventional diesel fuels. Some power plants have converted successfully to Bunker type fuel oil. A recent development of significant importance in the continued

(*Concluded on page 42*)

Profile

Dean Hollister

By NOBORU KONDO, ME '51

From an unpretentious but dignified office under Sibley Dome, one of the nation's top engineers and educators directs the operations of our College of Engineering. Yet few of the engineering students strolling by his office daily are aware of the distinguished professional background of Dean Hollister.

An indication of his authoritative position in the engineering field is the section on concrete he wrote for Urguhart's Civil Engineering Handbook. His interest in reinforced concrete construction dates from the first World War when he was the chief design engineer in the development of concrete ships for the U. S. Shipping Board. Another significant contribution of the Dean was in the research that made transit mixing possible. He is proudly reminded whenever he sees a mixer truck speeding concrete to some new construction project that his engineering talents are embodied in that basic modern construction material.

A member of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, he served from 1919 to 1940, as chairman of the important subcommittee on design. That he was formerly president of the American Concrete Institute perhaps best attests to his pre-eminence in that field.

As a consulting engineer for a number of projects in the late 1920's he soon became interested in the possibilities of structural welding. Before this new fabricating technique could be successfully utilized, the problem of thermal stress relief had to be solved. The results of the Dean's research on that problem are contained in the Welding Handbook.

Realizing the necessity for more rigorous methods of stress analysis, he returned to the academic scene, accepting an appointment in 1930 as Professor of Structural Engineering and Assistant Director of the Testing Materials Laboratory at Purdue. In this capacity, he made major advances in photoelastic methods of analysis. As consulting engineer to Babcock & Wilcox in the design and fabrication of the tremendous penstocks for Hoover Dam, he gave one of the most spectacular demonstrations of the potentialities of scientific analysis.

Dean S. C. Hollister

Underlying the Dean's achievements in the field of structural engineering has been an insatiable interest in the mechanics and materials of engineering, and the process of design. This overall interest is aptly epitomized in the Dean's prize-winning design of a skew arch bridge in Chester, Pa. The acute angle at which the bridge crosses the river and the unusual features of the surrounding terrain posed a most challenging engineering problem. By combining empirical knowledge with a thorough mathematical analysis, which included a formidable array of simultaneous differential equations, he arrived at a design which is as structurally safe as it is esthetically beautiful.

Leaving Purdue in 1934, the Dean came to Cornell to head the school of Civil Engineering, and in 1937 was appointed to his present position.

In what little leisure time he has at home, the Dean is fond of poring over his marine shell collection. While on vacation in Florida, he picked up some Pliocene fossils which he is presently studying with relation to evolutionary and geological considerations. This has led him into oceanography and paleontology, with only time imposing limitations on the scope of his interests. The Dean also has a fine collection of first editions of famous scientific works. As a leading scholar in the history of engineering, he recently conducted a conference on the history of mechanics for teachers of mechanics. In bygone days when he had more spare time, the Dean dabbled in sculpture and music, the flute being his forte.

One need only glance at Who's Who under the name of Solomon Cady Hollister to get an idea of the innumerable professional organizations with which he is affiliated. In 1946 he was a Vice-President of Cornell University, and at another time president of the International Association of Ithaca. His interest in foreign students has led in great measure to the high prestige of Cornell engineering abroad.

Despite his numerous technical achievements, the Dean may very likely be remembered in engineering history for his pioneering efforts in education. In recent years as chairman of various educational committees, he has been largely concerned with the establishment of a professional standard of engineering training. In his statement prepared as chairman of the Committee on Engineering Schools of

(Concluded on page 26)

PROMINENT

John

John W. Laibe, ME

Whenever there is a social event in the College of Engineering, you can be almost positive that John Laibe will be master of ceremonies. For in his four years at Sibley, John's friendly humor and quick wit have kept engineers slapping their slipsticks. But John's main love, outside of engineering, is the Varsity Track Team. His running prowess has earned him four major letters, plus the trophy for greatest improvement in track. His keen interest in the track team has been rewarded by his election as President of the Spiked Shoe Society, through which he has initiated the track team training table, and revived the pre-war Spiked Shoe newspaper.

John came to Cornell from Buchtel High School of Akron, Ohio, where he was as active as he is here. After the usual rushing, John joined Psi Upsilon, where he is now Corresponding Secretary. But John has never allowed his activities to interfere with his scholarship, having made Dean's List several times. In recognition of his accomplishments, John has been elected to Tau Beta Pi, winning their essay contest in 1949, Sphinx Head, Aleph Semach, Pi Tau Sigma, of which he was Treasurer, and Kappa Tau Chi.

This past summer John went to Europe with the track team, and now back at Cornell he has double-registered in the Law School, having been stimulated in barristry by the course in law for engineers.

John isn't sure as to where the future will lead him, but we are sure that he will always greet it with the aggressiveness and wit of the Big Red Bear.

Richard B. Brundage, EE

The ageless saga of "small town boy makes good in the big time" is ably typified on the Cornell campus by Richard B. (Barney) Brundage. Graduating from small Oakfield High School as valedictorian of his class, he was looked to for great things as he entered Cornell's E.E. School in the fall of '46.

Starting off with the usual frosh eagerness, he soon found that he could dive rather frequently into the extracurricular pool, and still keep ahead in the scholastic race. While performing his engineering assignments with deceptive ease, Barney pursued such varied activities as Frosh Crew, CURW, the Student Activities Center Board, and Cornell Shows, as well as the usual pledge functions of Sigma Pi. By his junior year, he had demonstrated to the powers-that-be the engineering competence and administrative ability that have led to his election to Tau Beta Pi and Eta Kappa Nu. Besides being the

(*Continued on page 26*)

Barney

Edward F. Watson, Jr., CE

Ed Watson thinks his engineering career began when he started taking apart bicycles, back in Larchmont, New York. From there he progressed to putting them back together, and eventually he ended up in engineering school.

Ed

After graduating from Mamaroneck High School in June, 1946, Ed followed in the footsteps of most of his family and enrolled in the Engineering College at Cornell. He started out as an electrical engineer, but after one term transferred to civil engineering—a wise move as evidenced by four terms on the Dean's List.

Sailing and scouting are Ed's major interests outside of engineering. In the summer he likes to take long overnight sailing trips on Long Island Sound and camping trips up to New England. His summer in 1949 was taken up by ROTC and civil engineering summer survey camp.

ENGINEERS

Ed's activities on campus include singing in the Sage Chapel Choir, Treasurer and House Manager of Zeta Psi, associate editor of the Transit, the national magazine of Chi Epsilon, and the presidency of the ASCE. He also belongs to Tau Beta Pi, Rod and Bob, Westchester Club and the ROTC Officers Club.

After graduation, Ed plans to go into sanitary engineering, which he feels is a growing field.

Howard A. Acheson, Jr., ChemE

Few know better than chemical engineers just how to use their time to their best advantage, but Howard A. Acheson has shown his mastery of that job, and of many others.

Feeling an interest in general business, Howie decided an engineering education was the best kind of preparation. And so he chose Cornell's Engineering College as the best place to get that training. His final plans are not settled, but he expects the experience he'll gain after graduation to help him choose his lifetime work.

But about that using of time to best advantage: Howie has a "C" in Cross Country for '47 and '48, and was on the Varsity Track Squad from '46 to '49. He's a member of Spiked Shoe and the Cross-Country Club. To round out a list of this kind, we find him in Sphinx Head, Pros-Ops, Scabbard and Blade, and Tau Beta Pi.

Last summer Howie traveled in Europe with his family, and for a few weeks was employed by an English firm, gaining some of that experience he feels is necessary to help him find his final career. He came back to Ithaca this fall to a position as a student counselor in one of the University dorms. He's also chairman of this year's Cornell Campus Charities Drive.

Howie

Theodore Schultz, Arch

In spite of the tough competition in engineering physics, Ted was elected to Tau Beta Pi at the beginning of his fourth year, an honor given to only two EP's. Yet this National Scholar and member of Telluride Association has maintained varied outside interests.

College first took him away from Glencoe, Illinois, to Deep Springs, California, for an intensive mathematical background. Then Cornell received Ted in its first EP class in the sophomore year. Since then he has been taking the normal load of courses in addition to auditing whichever ones he felt necessary, and he has remained at the top of his select class. This term he is proud of his schedule of three graduate courses and one required freshman machine tools course.

Varied interests? Well, he doesn't want his friends to know that he was once greatly interested in economics. His first avocation has always been music; ever since he can remember he has played the piano. He will not condemn modern music, because he does not claim to understand it, but his favorites are Cesar Franck and Beethoven.

Ted

In his first year at Cornell Ted became interested in WVBR and worked up to membership in the Cornell Radio Guild. He has tried his hand at dramatics, news broadcasting, and announcing for the campus station. The following year he entered into local politics as a very active member, organizer, committee chairman, and sometimes officer of the Students for Democratic Action and the Young Democrats. His enthusiasm led him to work for the Democratic Party in the congressional and mayorality races where he wrote news releases and ran sound tracks. Last year he had to modify his activities in deference to his heavy study load, but he did act Orlando in the Dramatic Club production of "As You Like It."

Summer does not always bring vacation. Ted has obtained excellent experience in his summer jobs, one summer doing research on electronic uses of glass. Last summer he was doing mathematical research with Philco Corporation.

You can guess from his summer occupation what ambitions Ted holds for his future. He wants first a doctor's degree in physics, and then—well, he is modest in his hopes. "I'm not much of an engineer," he says. "I'd rather evaluate an integral than look up tables in handbooks." In name of school only is he an engineer; he has the attitude and, we trust, the aptitude to lead him on to his goal of theoretical physics.

Cornell Society of Engineers

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George T. Minasian

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

President's Message

My first "message" is one of congratulations to the staff of the CORNELL ENGINEER for a splendid magazine and best wishes for the new year. Tom Kelly paid me a visit the other evening and told me about the plans for the coming year. I found it quite easy to catch his enthusiasm.

I suppose we all ponder the results of our college training and particularly try to figure out what we may have missed. It seems to me that a great many of us have felt, that in the pressure of getting through our engineering curriculum—there was too little time for learning about the business world of which we were to be a part. The five year course would seem to be a possible answer.

My own strong belief has been that engineers generally do not express themselves well either in writing or speaking. Conventions are a case in point. Splendid papers—technically masterpieces—complete, thorough but generally lacking the spark that catches the imagination—and moreover the engineer author usually reads his paper or even his few comments.

To be sure, engineering is a pretty exact science—one cannot expect to remember a lot of figures—the author must write out his material and check it with great care. But we can all read—what we would enjoy hearing is the Why, How and So What.

But what has the above got to do with the Cornell Engineers? Just this—I believe that the lads who can produce a monthly magazine like the CORNELL ENGINEER have probably gotten as valuable experience out of that job as any other single experience at Cornell. Extracurricular? Yes, in name, but with the advantage of meeting more engineers, and forming closer ties with not only engineering educators but engineers in industry.

Looking back—what did we miss? Perhaps it was the chance to edit and publish a magazine.

◇ ◇ ◇

Lest any forget—the Cornell Placement Service is very much alive. The New York office under Paul Reyneau is at the service of all Cornell Engineers—so whether you are an employer looking for men or employee looking for a new connection get in touch with Paul at 107 East 48th Street, New York 17, N. Y.

GEORGE T. MINASIAN

Alumni News

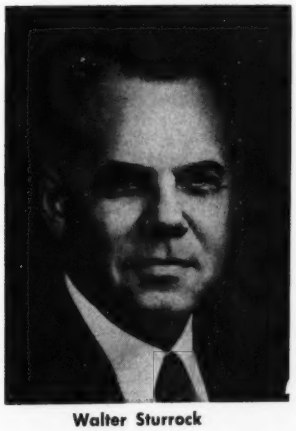
William T. C. Spiker, C.E. '00, consulting structural engineer, is a partner with his two sons in the Atlanta, Ga., firm of Spiker & Spiker. Address: Box 11, Mountain View, Ga.

The New York State Department of Commerce has named **Frank C. Chapman M.E. '07** and **William J. Russell, M.E. '13,** informal counselors to small businessmen who want Marshall Plan business. Both are regional directors for the Department, Chapman in Ogdensburg and Russell in New York City.

Perry T. Coons, M.E. '09, is assistant vice-president-sales of American Steel & Wire Co., a US Steel subsidiary in Cleveland, Ohio. He lives at 3270 Warrensville Center Road, Shaker Heights, Ohio.

Alexander T. Hayes, M.E. '14, 11 East Sixty-eighth Street, New York City 21, is in investment banking with Smith Barney & Co.

Walter Sturrock, M.E. '16, has been elected president of the Illuminating Engineering Society.



Walter Sturrock

He is head of the engineering publications section of the General Electric lamp department at Nela Park, Cleveland, Ohio, where he started to work the year he graduated. A lecturer at Case Institute of Technology and author of numerous technical papers, he was lighting counselor in Washington, D.C., during World War II. His work as an engineer officer in World War I gained him a citation from General Pershing. The Sturrocks, who have two children, live at 15002 Terrace Road, East Cleveland, Ohio. Other Cornellians of the former Ithaca family are **James Sturrock, Jr. '13,** Dr. **Alexander P. Sturrock '17,** Dr. **John Sturrock '18,** and Mrs. Theodore E. Thompson **(Elizabeth Sturrock) '30.**

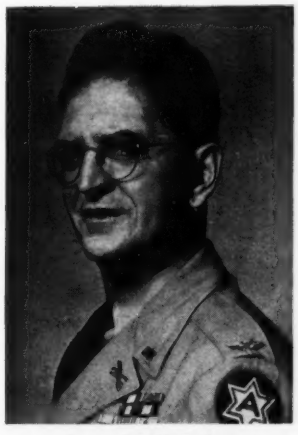
C. Hobart Sherwood, B.Arch '20, is architect for a new Saugatuck Congregational Church in Westport, Conn. On the church building committee is **Arthur W. Wilson, B.Arch. '15** and landscape architect is **Jo Ray, B.Arch. '25.** Sherwood, a former Cornellian editor-in-chief and a governor of the Westchester Cornell Club, lives at 7 Mitchell Avenue, Yonkers.

Brigadier General David H. Blakelock, C.E. '23, recently retired as Post Commander at Camp Stoneman, California, after completing a thirty-nine year distinguished career as an Army officer. While at Cornell, General Blakelock was elected to Tau Beta Pi, and served with the Cornell Cadet Corps.

Enlisting in the National Guard as a private in 1911, the general rapidly rose through the ranks. During World War II, he was awarded the Legion of Merit for outstanding service on the staff of Admiral Nimitz, and the Distinguished Service Medal for his contribution to the Okinawa campaign. More recently he received an Oak Leaf Cluster to the Legion of Merit for the important part he played in the atom bomb tests at Bikini.

General and Mrs. Blakelock now live in San Clemente, California.

Howard F. Eckerlin, B.C.E. '41, consulting engineer, has opened offices in the Palace Theater Building, Syracuse 6. He was formerly a structural engineer with an architectural firm.



General Blakelock

Peter M. Wolff, B.S. in A.E.(M.E.) '42, 416 Second Place, Uniondale, Hempstead, is national coordinator for Seaboard & Western Airlines, Inc.

Irving A. Cole, B.Chem.E. '43, is technical division manager for Attapulgus Clay Co., Camden, N.J. The Coles have two daughters, Kathleen L., three, and Mary J., one, and live at 120 Woodlawn Avenue, Merchantville, N.J.

Martin Burg, B.Chem.E. '44, 1984 West Twentieth Street, Los Angeles, Calif., is a sales engineer with US Rubber Co. mechanical goods division.

Robert W. Gerhard, B.Chem.E. '44, with Standard Oil. (Ind.), Mrs. Gerhard, Robert, Jr., five, and Mary Ellen, one, live at 842 Penning, Wood River, Ill.

(Continued on page 26)

RECENT DEVELOPMENT
IN ENGINEERING

Techni-Briefs

Monolon

A combination nylon monofilament and metal trolling line, extremely flexible and virtually non-kinking, offers a completely new type of fresh-and salt-water fishing. The new line, called "Monolon," is made of fine Monel wire braided around a nylon monofilament core.

In addition to preventing kinking of the line, the nylon core prevents flattening of the braided metal wire. The metal gives an added weight advantage highly desirable in a trolling line. Both nylon and Monel are non-corroding. "Monolon" will soon be available in a wide variety of weights suitable for all types of trolling.

AC-DC Railway

An experimental railway car equipped by Westinghouse Electric Corporation with d-c series traction motors supplied from an a-c trolley line is now in revenue service on the lines of a large eastern electrified railroad. Sealed ignitron tubes rectify trolley current for the motors. The new system combines all the advantages of high voltage a-c transmission of power with the superior characteristics of d-c, low-voltage series motors for traction. Tests to date show no difficulties from tubes misfiring due to motion of the car or troubles caused by ripples in the rectified current.

Leak Detector

Useful in developing high vacuum systems is the "halogen leak detector," capable of detecting a leak so slow it would pass only one ounce of gas in a century. It is an electronic device extremely sensitive to the presence of the elements fluorine, bromine, chlorine, and iodine. Infinitesimal leaks in pressure systems filled with gases containing these elements can be detected with the instrument, which sucks in air and registers the presence of any halogen on a control panel.

This stainless steel tube, placed in the path of exhaust from the jet engine in the background, is one end of a new periscope which enables engineers to study the pattern of burning gases. *—Courtesy General Electric*

Metamics

A fascinating new group of man-made materials called "Metamics" are a combination of metals and ceramics. Developed since the end of the war, they are produced similarly to powder metals and have two outstanding characteristics: they will stay solid where metals are molten, and they will not crack or break like ceramics when heated or cooled rapidly. They also possess interesting electrical characteristics.

New Zinc Alloy

A new alloy composed principally of zinc, with small quantities of copper and beryllium added, has approximately the same strength and electrical characteristics as brass, but is said to be considerably cheaper.

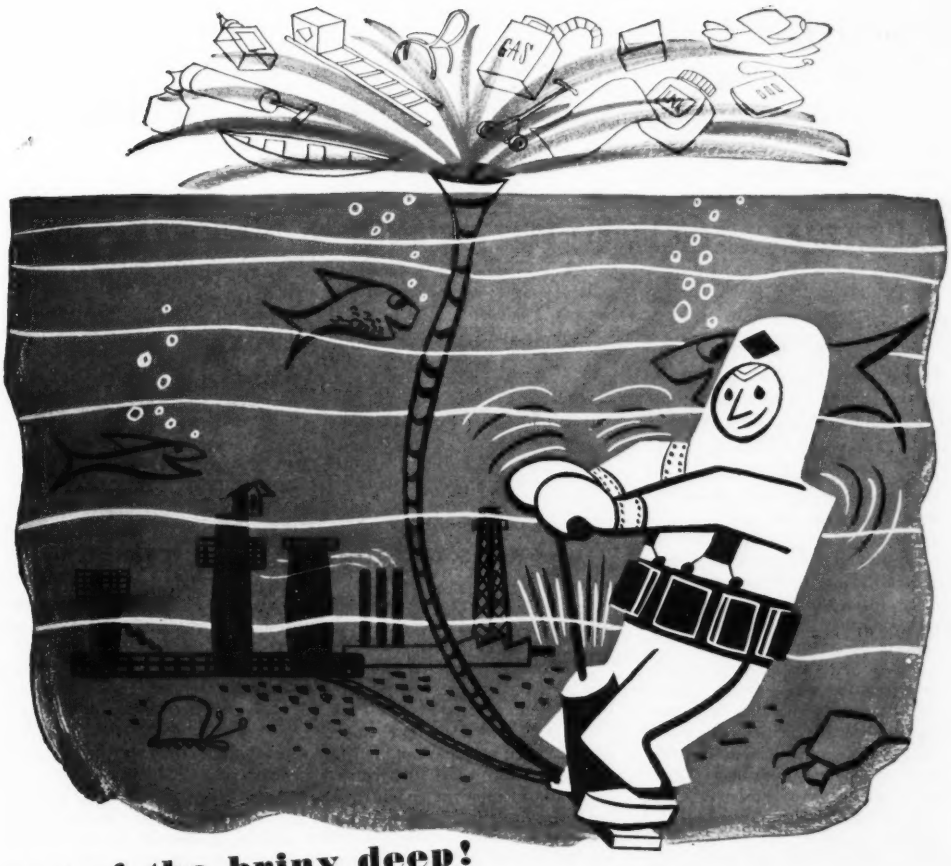
Called "zincube" from the chemical symbols of its makeup, the alloy has about eight times the useful strength of any zinc alloy now in use. It is said to machine, weld, solder and resistance weld easily.

Among applications where cheaper zincube might be substituted for brass are lamp and fuse sockets, containers, mild springs, and many forms of hardware.

Micro-Drills

Drills so small that it takes 20-power binoculars to watch them at work are opening new possibilities in the production of all kinds of consumer goods. The "micro-drills" are capable of producing holes as small as about one thousandth of

(*Concluded on page* 38)



out of the briny deep!

Metal furniture, lawn mowers, and materials for aircraft out of the briny deep? Drugs, ink, paper products, fumigants and photographic plates from ocean water?

Indeed, these products and many more owe their origin to elements extracted from the brine of the sea and from the earth's subterranean brines . . . bromine, iodine and magnesium.

The first of these, bromine, appears in a host of products which we use daily. For years this basic chemical has been produced for industry by The Dow Chemical Company. Bromine and bromine compounds are utilized in many fields including textiles, petroleum, solvents, fumigation, cosmetics, pharmaceuticals and a variety of others.

In addition to its medicinal use, iodine has many industrial applications, among them dyes and photographic film.

Magnesium, the lightest of all structural metals, is likewise extracted from the inexhaustible waters of the sea through a special process originated by Dow. Proved invaluable for over a decade in aircraft construction, magnesium today contributes strength without dead weight to many varied industrial and consumer applications.

Bromine, iodine, and magnesium are but three of over six hundred products manufactured by Dow in the interests of "chemicals indispensable to industry and agriculture."

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College News

CHALLENGE

An Editorial

Engineers, look around you! Notice anything different in the general attitude of engineers on the campus, in the actions of your professors and instructors, in your own estimation of the education you are receiving?

Perhaps you can't see at present that anything has changed. Some of the upperclassmen can; so can many faculty members. A general movement to unify the engineering student body is slowly getting underway. The general aims of this movement are: improved, personalized student-faculty relations; more student interest in the problems and operations of the Engineering Schools; and the development of a general school spirit among engineers, mainly through increased social activities sponsored by engineering organizations.

Much needs to be done in this field. Putting students and faculty on a more personally-acquainted basis would do much to relieve student complaints about certain courses, and add a feeling of mutual interest to otherwise dull classes. By showing some school unity, engineers could command more respect from the administration, and the suggestions of students regarding the school facilities, the curriculum, etc., would be worthy of more consideration. And certainly we engineers are missing plenty in not getting to know our fellow students socially as well as in class.

The logical leader of the school spirit movement should be the Engineering Council. Aside from its capable job in running E-Day, however, the Council has been unable to get the necessary support to make its presence felt. A strong Engineering Council *could* render much-needed services to engineers, such as coordinating the efforts of the various honoraries and professional societies, which at present operate haphazardly, with much duplication of effort and waste motion. The Council could also serve as an effective clearing-house of activities for the Engineering College, providing an interesting calendar of social and professional functions, and in general serving the best interests of engineering students.

To make the Engineering Council really fulfill its possibilities is the challenge we engineers face this year. The first step is for all engineers to learn all they can about the Council, and to keep abreast of its activities by reading the Council's newsletter. Then make suggestions for improving the Council, and increasing its effectiveness. With a little cooperation from students, the Council can be strengthened, and will soon produce concrete results of benefit to the entire Engineering College.

Dean's Message to the Freshman

It is a pleasure to welcome you to Cornell as members of the Freshman Class in Engineering.

I am sure that you have come to realize that you are entering now the most important phase of your preparation for a lifetime career. The direction and shape of your future very likely will be determined to a considerable extent in your next five years at Cornell. This fact will become evident, perhaps, in the first period of your professional experience, but especially as you work towards professional maturity twenty or thirty years hence you will find that you will have to depend upon your academic background as the foundation for your growth. These next five years are, therefore, the most vital investment for your future.

This thought has guided us in developing the curricula you are about to undertake. They are distinctly professional in scope and purpose, designed to give you the strength in the fundamentals of science and engineering upon which you can build your technical proficiency, and to stimulate you to develop your personal culture beyond technical areas so that you may take your place among the many Cornell Engineers who have gained distinction both as engineers and as leaders in human affairs.

I hope you will keep these broad objectives in view. As you go about your daily activities it will be easy to become completely absorbed in the accomplishment of that day's demands—to make that lesson or that course an end point in itself. It is well to apply yourself completely to the job at hand and to make your progress step by step, but I hope you will take time also to stand back and look at the overall pattern of your activities—to gauge the manner in which you are shaping a broad background of intellectual substance. Much of the value of your efforts here will depend upon your ability to master each study for its own purpose, and then to integrate all of your learning into a solid core of knowledge for your professional career.

I congratulate you on the opportunity that is before you. The College and its Faculty will watch your progress with warm interest and will assist you in every way to achieve a full measure of success.

S. C. Hollister, *Dean*
College of Engineering

and Views

Staff Change

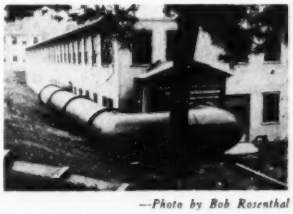
Robert H. Caplan, ChemE '51, is managing editor of the ENGINEER commencing with this issue. He succeeds John H. Gay, EP '51, who has retired after three years' service with the magazine. To John Gay, the ENGINEER's thanks for a job well done!

Lounge Contribution

Backing up its plea for student support of the Engineers' Lounge with concrete action the ENGINEER has contributed $100 to the Lounge. Several other campus organizations have also given to the Lounge Fund, with Tau Beta Pi's $300 donation the largest so far in the current drive.

New Wind Tunnel

Aeronautical research at Cornell is not limited to the Aero Lab in Buffalo. At the University's new 85-foot, low-speed wind tunnel, located behind the fluid mechanics laboratory near Beebe Lake, investigations of the turbulent boundary layer are being conducted. The project is under the supervision of Dr. William R. Sears, Director of the Graduate School of Aeronautical Engineering. Harry I. Ashkenas of Los Angeles, a research associate in the project, designed the new tunnel.



—Photo by Bob Rosenthal

Outside view of the new wind tunnel.

Looking into the business end of Cornell's new low-speed wind tunnel are Director William R. Sears (left) and Harry I. Ashkenas, designer of the tunnel.

—Courtesy Alumni News

Professor Cornell

Walter Rodney Cornell, professor of engineering mechanics, died at his home on May 27. He was 67 years old, and was to have retired on June 30, after serving on the College of Engineering faculty for 41 years.

Professor Cornell received the bachelor of science degree from Rutgers College in 1907 and the civil engineering degree from Cornell in 1915. He joined the Cornell faculty as instructor in 1909, after two years as instructor of civil engineering at Michigan State College. He became assistant professor in 1920 and professor of engineering mechanics in 1926.

While at Cornell, he had served as secretary of the Sibley School faculty, secretary of the Engineering Division of the Graduate School, chairman of the Sibley Scholarship Committee, and as a member of the general committee of the school.

School Societies

Tau Beta Pi

Tau Beta Pi, founded at Lehigh University, is a national scholastic honorary organization for men in all branches of Engineering. Cornell's chapter, having a membership of about eighty, is an active group in the College of Engineering. One of their outstanding projects is a slide rule class held each fall, one or two evenings each week, for the benefit of freshmen entering any of the engineering schools.

This year, the officers of the Cornell chapter are:

President .....Robert C. Schutt
Vice-President .....Loren Kahle
Treasurer .....Norman F. Kirchner
Rec. Secretary .....Albert B. Bishop
Cor. Secretary .....Robert H. Caplan
Cataloger .....Alton R. Pope

Pros-Ops

Pros-Ops is an honorary society for students in Chemical Engineering; eligibility for membership in the organization is based largely on extra-curricular activities. The principal functions of the group are social in nature, with parties and student-faculty events among the activities promoted.

This term's officers are:
President .....Joseph W. Calby
Vice-President .....Robert H. Caplan
Sec.-Treasurer .....Marjorie W. Leigh

Chi Epsilon

This national honorary society for civil engineers elects members from the upper third of the junior

(*Concluded on page 30*)

Only STEEL can do so many jobs

CLEANER THAN YOUR BEST CHINA. The inside of a food can is "surgically clean." Sterilized in processing, it is cleaner *and* safer than any dish. The Department of Agriculture reports, "It is just as safe to keep canned food in the can—if the can is kept cool—as it is to empty the food into another container." And, incidentally, did you know that "tin cans" are really about 99% *steel?*

HOW TO LIFT A MILLION POUNDS. This crane runway, whose structural steel was fabricated and erected by United States Steel for the San Francisco Naval Shipyard, is 730 feet long, 209 feet high, extends 162½ feet over the water at each side. It can lift gun turrets and other huge sections weighing as much as 1,000,000 pounds.

THE SOFTEST THING YOU CAN SLEEP ON IS STEEL. For solid comfort, you can't beat mattresses that have inner springs of steel. Especially if the inner springs are made of U·S·S Premier Spring Wire, specially developed by United States Steel to give lasting resiliency and buoyancy to the inner springs of sleep equipment and upholstered furniture.

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so well...

NEW ICE CREAM IDEA. In certain parts of the country, you can now buy individually packaged single servings of ice cream. They're called "Diced Cream"... and they strike a new high in sanitation, economy and convenience. Diced Cream is made in machines fabricated largely from stainless steel—to assure maximum purity in the finished product.

STAINLESS STEEL GOES TO SCHOOL. What a change from the little red schoolhouse! This new school in California embodies the latest features in school construction, including the use of U·S·S Stainless Steel for architectural trim. The stainless trim resists atmospheric corrosion, harmonizes with the building design. United States Steel produces steel of all kinds for such buildings . . . continuing its number-one job of helping to build a better America.

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Dean Hollister

(*Continued from page* 19)

the Engineers' Council for Professional Development, he characterizes the engineer by "his ability to creatively apply scientific principles to design." But in an interview, the Dean elaborated on this statement, and warned against the tendency of the engineer to become proccupied with technical matters. "Engineers do not pay enough attention to the human element as they are apt to be misled by their courses dealing with inanimate things. They may overlook the fact that everything has to be accomplished by people, after all."

Cornell's Five-Year Engineering Curricula stem largely from the Dean's profound conviction that engineers require a broadening of their viewpoints towards the humanities and social sciences as well as a strong foundation in the basic sciences and technologies. The Dean stressed the strong desire of the Cornell faculty to help the students, not only in class but as individual people.

Summing up his views on engineering, the Dean stated:

"I look upon engineering as a profession of fundamental importance to our way of life. The work of the engineer is essentially a service to the community in a specialized area. The interest of the engineer is therefore that of the community at large. It isn't possible for the successful engineer to isolate himself in the technique of engineering to the exclusion of the other interests of the community. He should aim ultimately to integrate himself with the community."

Alumni News

(*Continued from page* 19)

The following is a list of some of the June '50 graduates who have accepted jobs:

George P. Adams, B.E.E.
Niagara-Mohawk Power Corp.,
Buffalo, N. Y.

Albert C. Dutton, B.Ch.E.
DuPont, Rayon Division,
Wilmington, Del.

James G. McMillan, Jr., B.Ch.E.
Hercules Powder Co., Parlin, N. J.

William M. Marcussen, B.Ch.E.
Atlantic Refining Co.,
Philadelphia, Pa.

Jerome J. Hargarten, B.Ch.E.
DuPont, Niagara Falls, N. Y.

Leonard Roland, B.Ch.E.
U.S. Rubber Co., Providence, R. I.

George D. Russell, B.M.E.
R. R. Donnelley and Sons,
Chicago, Ill.

Harold J. Sandwick, Jr., B.E.E.
Brewer-Titcheuer Corp.

John H. Smith, B.E.E.
Westinghouse Electric Co.,
East Pittsburgh, Pa.

Don N. Thomson, B.E.E.
Philco Corp., Philadelphia, Pa.

Richard F. Tucker, B.Ch.E.
Standard Oil of New Jersey,
Elizabeth, N. J.

Journ T. Yee, B.C.E.
Howard F. Ackerlin, Consulants,
Syracuse, N. Y.

Charles P. Yohn, B.M.E.
Aluminum Co. of America,
Edgewater, N. J.

Prominent Engineers

Richard B. Brundage

(*Continued from page* 16)

present secretary of the letter, he is also chairman of the student branch of the AIEE. But Barney has not forgotten his high school love of athletics, and now manages the varsity wrestling team, consequently belonging to the Varsity Managers' Club. A military enthusiast, he took advanced ROTC, was elected to Scabbard & Blade, and received his reserve commission last June.

Professionally, the communications field claims Barney's chief interests, probably the sales or administrative phase, following a possible year or two in graduate school. But, as he says, "That's an awfully long way off."

It is surprising to learn that, to a promising EE like Barney, the decision to follow a course in electrical engineering was almost an afterthought. For almost until actual entrance, he definitely preferred chemical engineering, but an electrical shop course in high school convinced him that E.E. was his dish. In any case, Franklin's got him, and Barney says he likes it and intends to stay.

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K & E drafting instruments, equipment and materials have been partners of leading engineers for 81 years in shaping the modern world. So extensively are these products used by successful men, it is self-evident that K & E has played a part in the completion of nearly every American engineering project of any magnitude.

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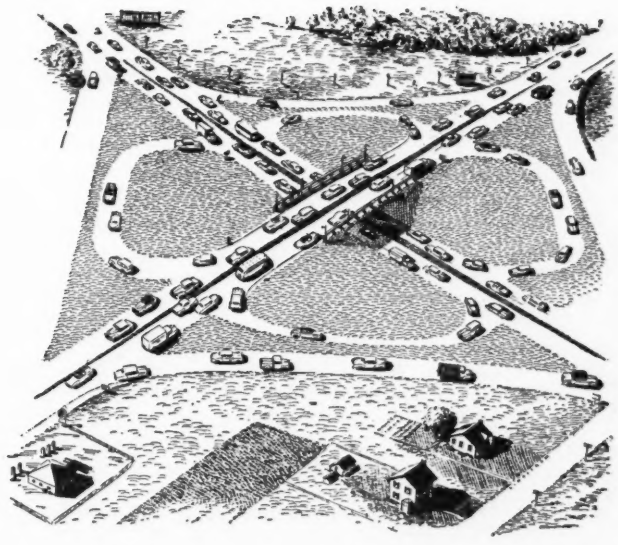

The forgotten half billion

Roebling Aircord contributes importantly to safe, sure control in the air
Roebling Elevator Rope is the most widely used wire rope in elevator service
Roevar Magnet Wire insulation is 10 to 40 times tougher than other types

IT'S EASY to forget a product that gives almost flawless performance. Most people, for instance, never think of the valve springs in their cars... largely because wire developments have brought them to a point approaching metallurgical and mechanical perfection. The half billion valve springs in service today... closing each valve as often as 12 times a second, from sub-zero temperatures to 400°F... will prove almost 100 per cent dependable for years on end. Roebling is a chief supplier of round spring wire to valve spring manufacturers.

Today, too, Roebling's wide line of wires and wire products offer economies to *every* field of industry. A full range of high carbon specialty wires... wire rope for every sort of rope-rigged equipment... more than 60 types of electrical wire and cable... a complete range of woven wire screens. Write for information about the Roebling products of interest to you.

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A CENTURY OF CONFIDENCE

Men and Electrons

(*Continued from page 7*)

know as static electricity, Gilbert is also noted for the discovery of the first electrical detecting instrument. The device consisted of a straw, pivoted at the center like a compass needle; the approach of charged objects to one end of the straw caused a rotation on its axis. Thus was born the forebearer of the familiar gold leaf electroscopes, which are standard equipment today in laboratories all over the world.

About the time of Gilbert's death there was born in Magdeburg, Germany, a youngster who was to invent the first electrical generating machine. Otto von Guernicke first became interested in the results of Gilbert's experiments at an early age, and he set about to devise a way of manufacturing this stuff which the Greeks had termed "elektron." After many unsuccessful attempts, he succeeded with a machine consisting merely of a globe of sulfur which was rotated on a shaft. A leather glove was caused to be pressed against the surface of the rotating sulfur globe. As Von Guernicke had anticipated, the sulfur soon attracted nearby particles of dust and feathers; but, after touching the surface of the globe, the particles were suddenly repelled. Unfortunately, he did not realize the significance of this remarkable phenomenon. It remained for a Frenchman, Charles DuFay, to carry on the experiments and arrive at the fundamental law that "like charges repel, and unlike charges attract."

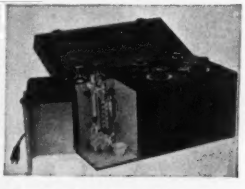
DuFay had performed most of the electrical experiments which had been known in his day (1698-1739), but he made the startling discovery that, while sealing wax rubbed with cats' fur became electrified in the same way as a glass rod rubbed with silk, yet the two charged bodies had different properties when charged. To explain this fact, he proposed that there were two kinds of electricity, called "resinous" and "vitreous." He then stated further that like kinds repelled each other, and that unlike kinds attracted. It was not until some years later that Benjamin Franklin suggested the now familiar terms "positive" and "negative" electricity.

The Leyden Jar

While von Guernicke and DuFay were able to make advances in the study of static electricity, they were hindered by their inability to accumulate any considerable amounts of static electricity in one place. Because the rubbing process produced only small amounts of charge, their experiments were all qualitative in nature, and no significant quantitative data could be obtained. The solution to this problem was finally provided by Pieter van Musschenbroek, a Dutch physics professor at the University of Leyden. His discovery, like many great

(*Continued on page 31*)

CAMBRIDGE electron-ray RESEARCH pH METER



RANGE AND ACCURACY: Sensitivity .005 pH; readings reproducible to .01 pH; accuracy .02 pH. Range 0 to 14 pH; 0 to 1200 M. V. *ELECTRON-RAY NULL INDICATOR:* Replacing the usual galvanometer, the electric eye provides quick and accurate null-point indication without possible damage to a delicate galvanometer. *NO BATTERY NUISANCE:* All-electric; plugs into any 110-volt AC Outlet. *ELECTRODE SYSTEM:* Sturdy glass electrode of condenser type is supplied. Micro or other glass electrode can also be furnished. *COMPACT AND PORTABLE.* Laboratory and Industrial Models also available. *Send for Bulletin 910 MA.*

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Weight 3½ oz.

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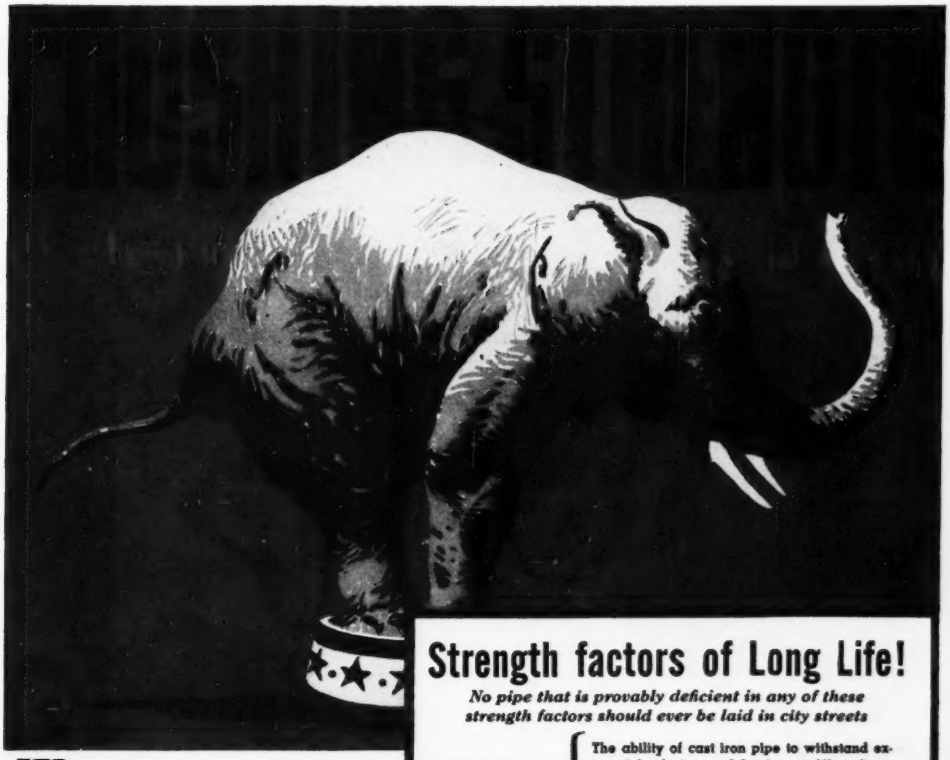


Strength factors of Long Life!

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets

CRUSHING STRENGTH — The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH — When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

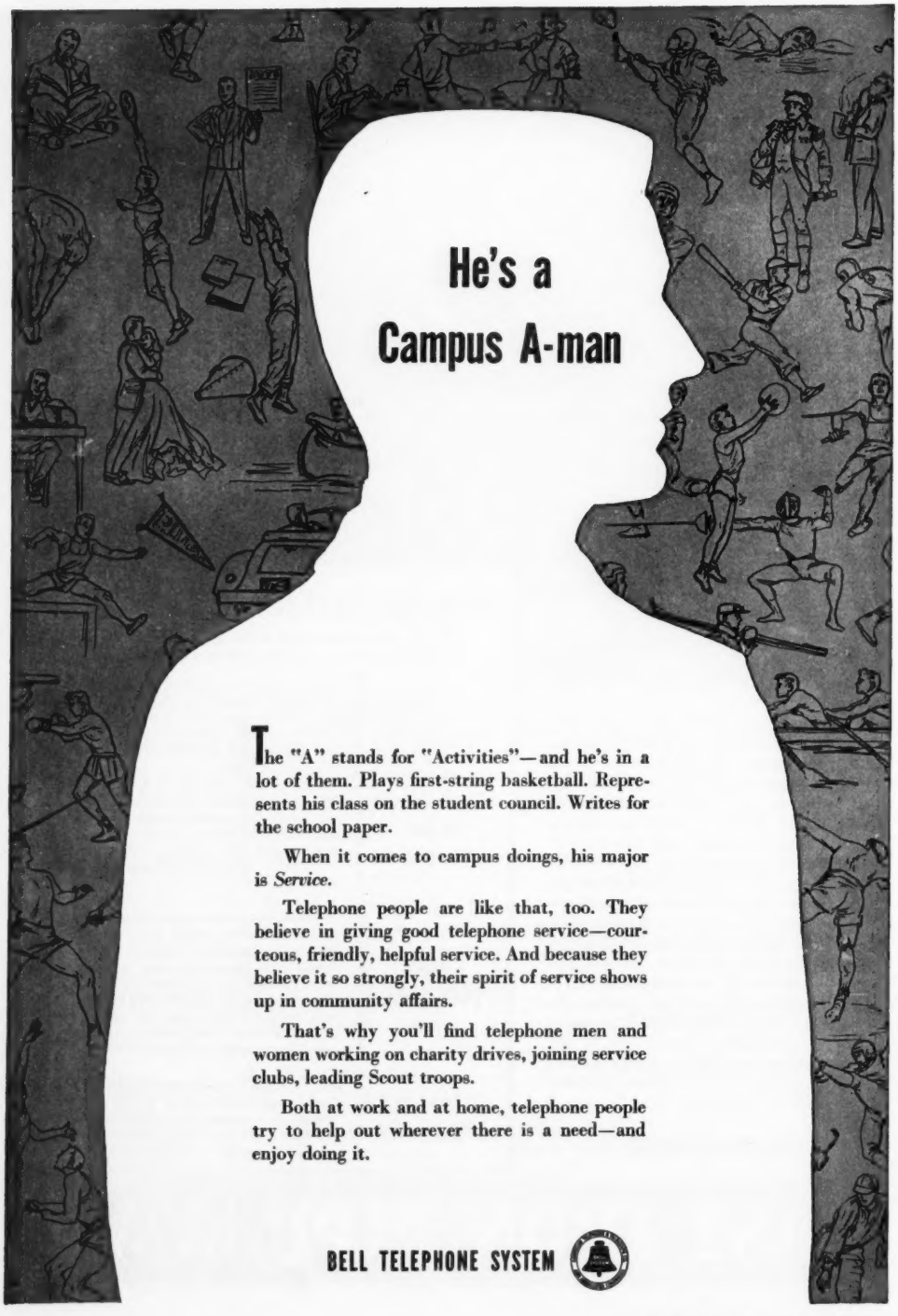
SHOCK STRENGTH — The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times on *the same spot* from progressively increased heights of 6 inches.

BURSTING STRENGTH — In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

Without crushing strength—or, for that matter—without all of the strength factors listed opposite—no pipe laid 100 years ago in *city streets* would be in service today. But, in spite of the evolution of traffic from horse-drawn vehicles to heavy trucks and buses—and today's vast complexity of subway and underground utility services—cast iron gas and water mains, laid over a century ago, are serving in the streets of more than 30 cities in the United States and Canada. Such service records prove that cast iron pipe combines all the strength factors of long life with ample margins of safety. No pipe that is provably deficient in any of these strength factors should ever be laid in city streets. Cast Iron Pipe Research Association, Thos. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3.

CAST IRON

CAST IRON PIPE SERVES FOR CENTURIES



He's a Campus A-man

The "A" stands for "Activities"—and he's in a lot of them. Plays first-string basketball. Represents his class on the student council. Writes for the school paper.

When it comes to campus doings, his major is *Service.*

Telephone people are like that, too. They believe in giving good telephone service—courteous, friendly, helpful service. And because they believe it so strongly, their spirit of service shows up in community affairs.

That's why you'll find telephone men and women working on charity drives, joining service clubs, leading Scout troops.

Both at work and at home, telephone people try to help out wherever there is a need—and enjoy doing it.

BELL TELEPHONE SYSTEM

Men and Electrons

(*Continued from page 28*)

discoveries, was quite an accident. He had been trying unsuccessfully to electrify some water in a jar by simply connecting a terminal of his static generator to a strip of metal immersed in the water. One day, a pupil of his was inadvertently holding the water-filled jar in his right hand while the metal strip immersed in the water was connected to the static generator. The unknowing pupil then withdrew the charging conductor with his left hand, and was greeted by a shock which caused him to drop the jar. Today, of course, we would simply say that the condenser had discharged through him; for this, indeed, was the first condenser. The others in the laboratory came running at the sound of crashing glassware; and when his pupil told him of the strange occurrence, Van Musschenbroek insisted upon performing the experiment himself, whereupon he too received a jolting electric shock. Obviously all that was needed now was a substitute for the human element in the experiment, and it was soon discovered that a coating of metal on the outside of the jar served just as well as the lab assistant's right hand, and was considerably less painful for all concerned. Thus was born the Leyden jar, the forerunner of the various condensers used today for all types of electrical equipment.

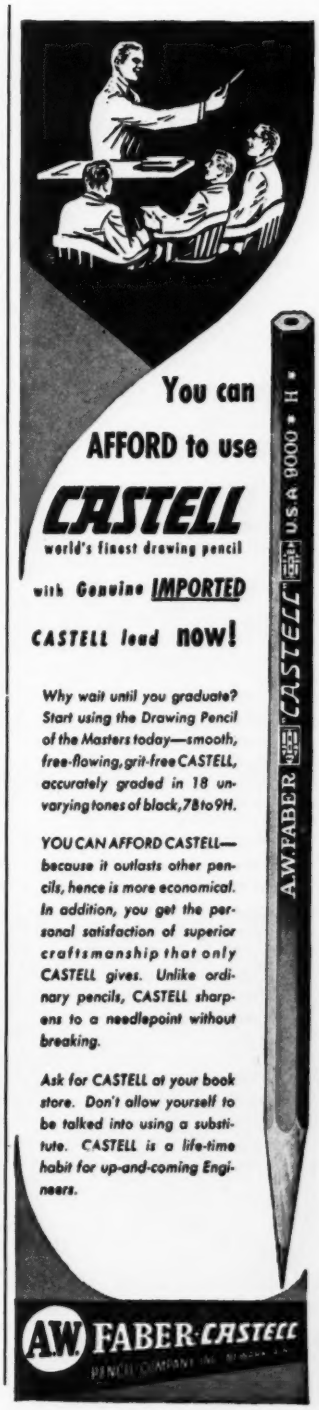
American Efforts

Europeans, however, were not to completely monopolize early advances in the study of electricity. Ben Franklin, not satisfied with his roles as printer, statesman, philosopher, and writer, had often turned his tremendous abilities and energies to inquiries into the infant science of the electron. It was Franklin who first sensed that electricity was composed of small, discrete particles, for he is quoted as saying, "The electrical matter consists of particles extremely subtile, since it can permeate common matter, even the densest metals, with such ease and freedom as not to receive any perceptible resistance." But it is in connection with his experiments with lightning flashes that Franklin is best remembered. He had long suspected that lightning and electricity were the same entity, and in 1750 he had invented the lightning rod so that, in his own words, "electrical fire might be drawn silently out of a cloud before it came nigh enough to strike." Two years later, he set out to prove the synonymity of lightning and electricity in a now famous experiment. His main equipment consisted of a large kite, which had a short wire projecting from one of the cross-pieces. The wire was connected to the kite string, which became an electrical conductor as it was wet by the rain; and Franklin was able to draw sparks from the string with a metal key. Fortunately, the kite string was a very poor conductor at best, or the elder statesman would never have reached his ripe old age of eighty-four.

Electrical Units

While much had been learned about electricity by Franklin, DuFay, Gilbert, and the others, these men had answered only the question "What?", "Why?", and "How?". It was left for a Frenchman, Charles Augustin De Coulomb, to begin answering questions such as "How much?" and "How many?". As might be expected, De Coulomb was fundamentally a mathematician, and it was through his application of mathematics to electricity that he contributed so much to the study of electrostatics. By his invention of the torsion balance, he made possible the measurements of extremely minute forces, and it was this invention which led to his formulation of the law which now bears his name. While Gilbert had used his pivoted straw electroscope to detect forces of electrical origin, no attempt was made by him to discover the magnitude of those forces. It was not until two hundred years later that De Coulomb proposed that the forces between two charges varied directly as their product and inversely as the distance between, which we now know as Coulomb's Law. In tribute to this and his numerous other less important discoveries, the fundamental unit of electric charge has been named the coulomb.

(*Concluded on page 34*)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BOTTLENECKS

Have No Place in Production—or in Your Future Progress!

by CHESTER E. MEYER
Superintendent, Production Scheduling
General Machinery Division
ALLIS-CHALMERS MANUFACTURING COMPANY
(Graduate Training Course 1938)

PRODUCTION CONTROL in a big plant like the Allis-Chalmers West Allis Works is a constant campaign to prevent bottlenecks and keep orders moving along smoothly to meet scheduled shipping dates.

CHESTER E. MEYER

Most men face much the same kind of personal problem when they get out of engineering school and plan a program of graduate training and experience leading to a firm position in the work they want to do. They can't afford to risk bottlenecks and blind alleys in that program, either.

Big Opportunity

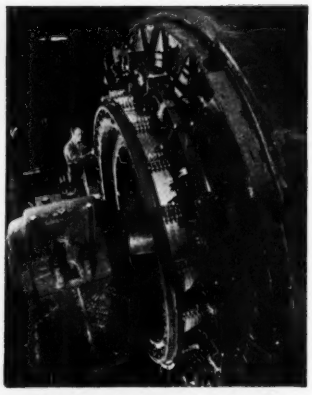
I had this in mind when I graduated from MIT in 1936 and enrolled in the Allis-Chalmers Graduate Training Course. I'd been particularly interested in production and sales. I was looking for practical training, experience and opportunity. And I got them.

First assignment was in Steam Turbine erection. Then I went to the Centrifugal Pump Department, and worked on cost analysis. This job gave me a chance to study plant layout and manufacturing methods, and put me in contact with the Time Study and Planning Department. I liked the work, and finished up the course in that department. I've stayed in the same type of work ever since.

Here in Production Scheduling we pick up each job after the Planning Department has established the routing. It's up to us to set a shipping date, and then work out dates when the job is to be completed in the various shops through which it must go. This requires a thorough knowledge of methods, shop capacities and work loads throughout the entire plant.

Great Diversity of Products

To give some idea of the extent of this operation, here are a few facts about the West Allis Works: The floor area of the buildings is more than 160 acres. There are 14 miles of railway and 4 miles of roads within the plant, and the shops contain more than 30,000 power tools, from small precision machines to the great 40-foot boring mill. It requires 208 traveling cranes to handle materials and equipment. There are twelve great machine, assembly and erection shops, three foundries, pattern shop, tank and plate shop, forge shop, mill shop and many miscellaneous buildings used in manufacturing.



Assembling big direct-current blooming mill motor for test—last step in the manufacturing process before shipment and final installation.

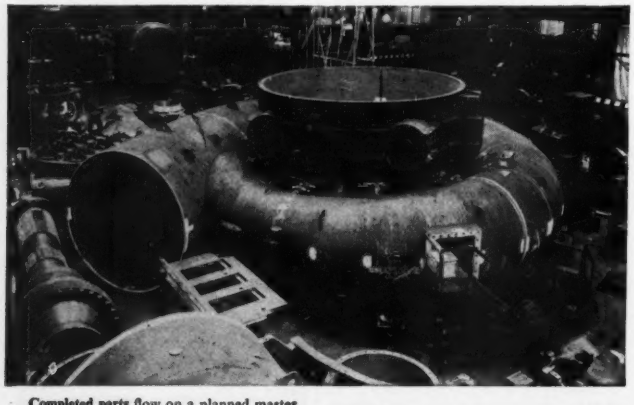
Some of the big jobs going through now include a 107,000 kw steam turbine unit for a midwest utility and two complete new hydraulic turbine and generator units for Hoover Dam. There's an order for six 22,000 hp pumping motors for a West Coast irrigation project, and another for one of the largest power transformers ever built. Rotary kilns up to 400 ft. in length, gyratory crushers weighing 500 tons and 22 million volt Betatrons are all products of these shops. So are delicate electronic and control devices.

Allis-Chalmers designs and builds basic machines for every major industry: steam and hydraulic turbine generators, transformers and other equipment for the electric power industries; crushers, grinding mills, rotary kilns, screens and other machines for mining, ore processing, cement and rock products; flour mills and oil extraction plants; electronic equipment; big pumps, motors, drives . . . to name just a few.

Widest Choice

As you can see, Graduate Training Course engineers at A-C can move in just about any direction they choose—any industry, any type of work from machine design, research and product engineering to manufacturing, selling and installation.

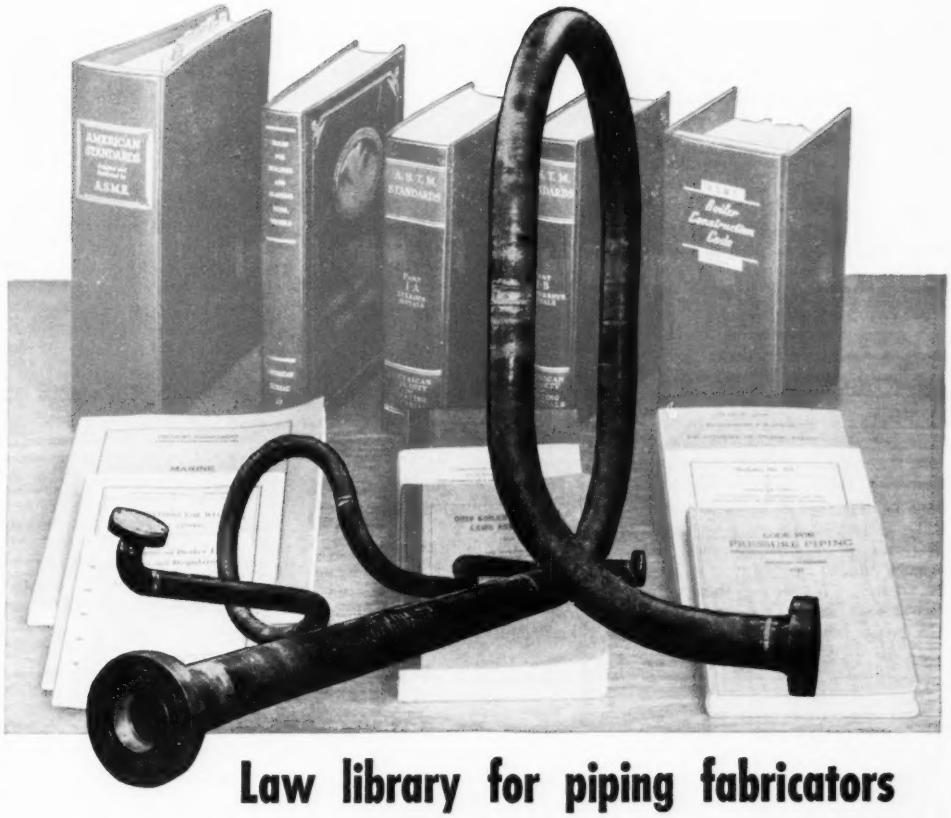
The course is set up to allow students plenty of chance to gain training and experience in the work they choose. There's no reason to run into bottlenecks or dead-end streets—for students help plan their own courses, and are free to change their plans as new interests, new opportunities, present themselves.



Completed parts flow on a planned master schedule from all parts of the great West Allis Works as this large turbine unit takes form. This is a general view of a part of the vast erection shop.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



Law library for piping fabricators

The safety of employees, the welfare of the community and a major investment can depend on a single piece of prefabricated piping. That's what piping codes are for . . . state, national, association and insurance codes. Grinnell engineers know the "law" intimately, check and cross-check with these codes at every step from preparation of detailed drawings and specifications right through bending, welding, stress relieving, heat treating, final inspection, assembly and test runs.

That's just one of the many advantages of having a piping system prefabricated by Grinnell.

The complete "package" includes interpretative engineering, metallurgical research, compliance with code requirements, manufacturing drawings and specifications, production schedules, purchase of materials, specialized facilities, skilled personnel, control of quality and rigid inspection.

Such knowledge and careful attention to all requirements of simple or complex jobs is typical of Grinnell's complete piping service which provides the products, facilities and service required "whenever piping is involved".

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ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL.

Men and Electrons

(*Continued from page* 31)

Up to this point, attention had been focused exclusively on charges at rest. It was not until the middle of the Eighteenth Century that Luigi Galvani, an Italian anatomist, inadvertently discovered current electricity; unfortunately he was very much in error concerning the nature of his discovery, and it remained for a fellow countryman, Allessandro Volta, to propose the true nature of current electricity and a means of generating it. The story of Galvani's accidental findings has a number of varied versions, but they all seem to agree on the fact that Galvani was extremely short sighted to have missed the point of his momentous discovery. He had noticed that the skinned legs of a frog would convulse when touched with a metal scalpel; this strange reaction intrigued him, so he tried it with various kinds of metal, and then with two metals at the same time. In the latter case, he found the convulsion was much more pronounced than if any single metal were used alone. Galvani then immediately assumed that he had discovered a new entity, "animal electricity," which was the secret of all life. Volta refuted Galvani's erroneous beliefs, proposing correctly that the frog's legs were merely acting as a very sensitive electroscope; the point which Galvani had missed completely was that electricity had actually been generated by the contact of the two dissimilar metals. From this humble beginning was developed the whole theory of generating electrical energy from chemical energy in a battery or cell.

Vola quickly cast about for a means of direct application of Galvani's new discovery; his first cell was merely a series of cups containing a salt solution, into which were immersed plates of zinc and silver. Each silver plate was connected to the zinc plate in the next cup, and the terminal plates or silver and zinc were joined; this was the world's first series arrangement of cells. This, the invention of the Voltaic cell, constituted the greatest single advance in the field of electricity until the invention of the generator or dynamo some time later.

Thus ends the first chapter of the story of electricity and its relations with man.A great deal has been done since these men threw their last switch; so much, in fact, that it is easy to forget that there were men 'way back who laid the groundwork for all our complex technical know-how today. But someone has to begin things; and most things are begun in a modest manner. Electricity had to come into its own slowly; but now that it has arrived, it is well to remember those who did the spadework, that we of the Twentieth Century might have such conveniences as the telephone, wireless, radio, electric light, and motion picture—all operated by millions of electrons just like the ones old Thales rubbed off the chunk of amber over 2500 years ago.

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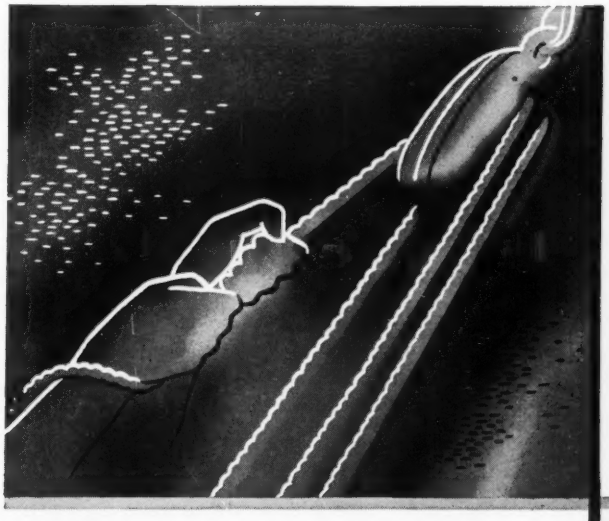

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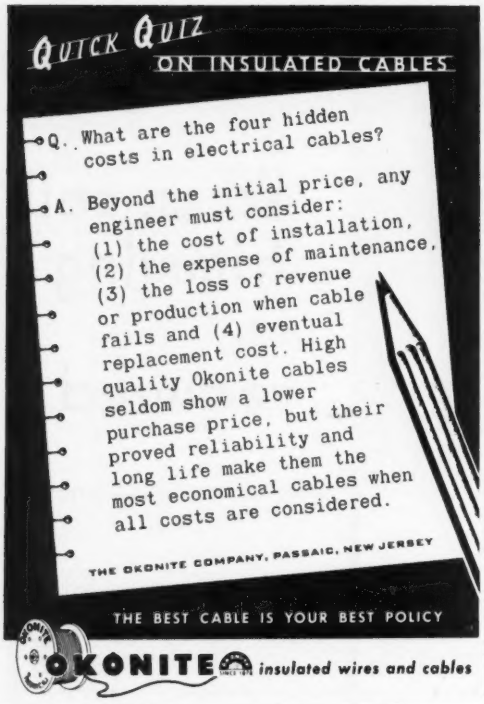
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ON INSULATED CABLES
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A. Beyond the initial price, any engineer must consider: (1) the cost of installation, (2) the expense of maintenance, (3) the loss of revenue or production when cable fails and (4) eventual replacement cost. High quality Okonite cables seldom show a lower purchase price, but their proved reliability and long life make them the most economical cables when all costs are considered.
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BALL AND ROLLER BEARINGS

School Societies

(*Continued from page 23*)

and senior classes. Seeking to improve the instruction in the C.E. school, the Society conducts a course survey, which may be extended to include required courses in other schools.

The officers for this term are:
President .....Norman Kirchner
Vice-President .....Edward Watson
Sec. Treasurer .....Thomas Nuttle
Transit Assoc. Ed., Edward Watson

Eta Kappa Nu

The Cornell Chapter of Eta Kappa Nu, a national organization, is the scholastic honorary society for men in Electrical Engineering. One of the outstanding contributions of the organization to the school is their annual course survey, covering all of the courses of the School of Electrical Engineering.

Directing the activities of the society for the coming year will be the following men:
President .....Theodore J. Holmes
V-Pres. .....Albert B. Bishop, III
Treasurer .....Louis C. Paine
Rec. Secretary R. Barney Brundage
Cor. Secretary .....T. Terry Burger

Kappa Tau Chi

The scholastic honorary society for men in the administrative option of the Mechanical Engineering Society, Kappa Tau Chi, has been active at Cornell since 1933. Striving to promote activities which will benefit the Administrative Engineering program at Cornell as well as improve student-faculty relations in the Sibley School, the organization originated the project which, last Spring, made the Engineers' Lounge a reality.

Officers of the organization for the current year are as follows:
President .....William G. Jennings
V-Pres.-Treas., Richard L. Freeman
Secretary .....Philip F. Gottling, Jr.

Pi Tau Sigma

Pi Tau Sigma, a scholastic honorary society for men in mechanical engineering, is a national organization represented at Cornell by the Pi Tau chapter. This group of some fifty men is actively serving the school, taking a leading role in raising funds for the Engineers' Lounge, and conducting review classes in preparation for the Professional Engineers' License exams.

For the 1950 Fall term, the officers of the organization are:
President .....Robert L. Hammon
V-President .....Thomas J. Kelly
Rec. Secretary .....Richard K. Teed
Cor. Secretary .....William S. Neef
Treasurer .....Peter D. Spencer
Soc. Chairman, William G. Jennings

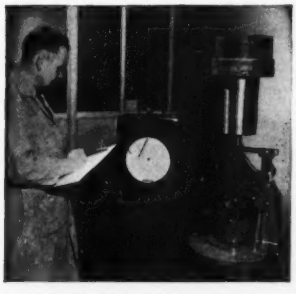
Aluminum melts at 1217°F....

What's the melting point of fused aluminum oxide?

- ☐ *1652°F.*
- ☐ *2732°F.*
- ☐ *3272°F.*
- ☐ *3722°F.*

Not 1652°F. which is a bright red heat; nor 2732°F. which is white heat; nor 3272°F., the highest temperature in a blast furnace.

Yes, the melting point of fused aluminum oxide (as made by Norton from the mineral bauxite under the registered trade-mark Alundum) is 3722°F. That's why it's such a popular refractory material. Because it also possesses high thermal conductivity and low electrical conductivity when hot, it is used extensively in both fuel and electrically heated furnaces.



In the Norton Mechanical Laboratory W. M. Wheildon, Jr., B. S. and M. S., Massachusetts Institute of Technology '30 and '31, takes readings on a wear-testing machine which he developed.

Harder Than Cemented Tungsten Carbide

Alundum grains in various crystalline structures are widely used as abrasives. On the Knoop scale, they have a hardness of 2000, the same as the sapphire.

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In the Norton Ceramic Laboratory O. J. Whittemore, Jr., B. S., Iowa State '40, operates a load test furnace of his design — a furnace that tests refractories at temperatures up to 2450°C.

32 Alundum Abrasive

The crowning achievement in aluminum oxide chemistry was the creation by Norton of a unique single-crystal grain structure of unusual sharpness. Named "32 Alundum," it has been hailed as the "greatest abrasive contribution to increased grinding production in more than 40 years."

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Book Review

MATERIALS ENGINEERING OF METAL PRODUCTS *by Norman E. Woldman. Reinhold Publishing Corporation,* $10.00

In the formal training of an engineer much time is usually spent in courses dealing with the design of machine elements and machines where the stress analysis aspect is emphasized. Additional time is also spent in the study of materials, particularly metals, where the emphasis is placed on the fundamentals of their structures. One of the most difficult things to accomplish is the correlation of these two fields of study which would enable the designer to more fully understand what materials he can use to best advantage and the metallurgist to know more about the service conditions under which the metals he develops must

Typical of the chapters which are helpful in bridging the gaps between the design of the part, the materials used and the service conditions imposed is the one on gear materials. A brief review of a descriptive nature covers the various types of gears required by industry. This is followed by a discussion of such subjects as gear terminology, requirements of a gear in service, and selection of a gear material. Next is a group of sections devoted to gear steels and the various heat treatments used, cast irons, bronzes, powdered metals, welded gears, and the various non-metallic gear materials. The chapter concludes with a discussion of the durability of gear teeth, types of wear encountered, methods of failure, lubrication, and gear design.

Other chapters of this general type cover spring materials, bearing materials, threaded fasteners, electrical contacts, and thermostat materials. Specific applications are also dealt with in other chapters which have more general titles such as magnetic materials, electrical resistance alloys, corrosion-resistant materials, and high temperature materials.

Reviewed by P. E. Kyle, Professor of Metallurgy

Techni-Briefs

(*Continued from page 20*)

an inch in diameter. Among the many uses found for such holes is the drilling of minute dies for squeezing synthetic silk materials into fine synthetic threads. The accurately made steel drills used for such holes are far thinner than a human hair and operate under pressure so light the operator can hardly feel it. Nozzles of fuel injection engines also require extremely small holes. The first major application of micro-drilled holes in the medical field is the new "hypo-spray" for hypodermic injections. The drills are also expected to help the U.S. watch industry compete better with the Swiss.

Water Purification

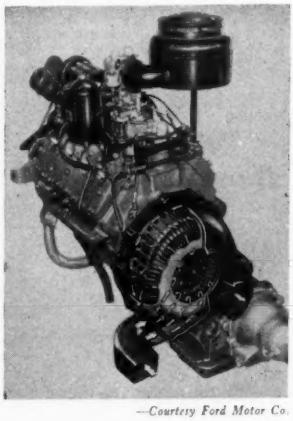
The largest water purification plant of its kind in the United States, Philadelphia's Welsbach Corporation installation uses ozone, a form of oxygen, to kill river water bacteria.

In the process, outside air is compressed, cooled, and dried. Then the air is blown past banks of metal plates charged with high voltage. The electricity from the plates causes an electrostatic discharge to take place within the passing air, producing ozone, an unstable type of oxygen. The ozone is bubbled through river water from which the sediment has been allowed to settle. Its instability causes it to break down again into ordinary oxygen, killing the bacteria in the water as it does so. The water is then sent to the city's water faucets, free from the odor that usually accompanies water that has been purified by chlorination.

Bending Radio Beams

Radio waves are being "bounced" around a mountain in Pennsylvania. A microwave communication system recently installed between a sub-station and generating plant of the Pennsylvania Electric Company has shown the reflection principle to be both efficient and economical. The sub-station and generating plant are twelve miles apart and the expense of installing and maintaining multiple telephone lines for control purposes would have been considerable.

Microwaves seemed to offer a solution. However, like television, these waves travel only in a straight line and in this installation there is a large hill between the sub-station and the generating plant. Since the



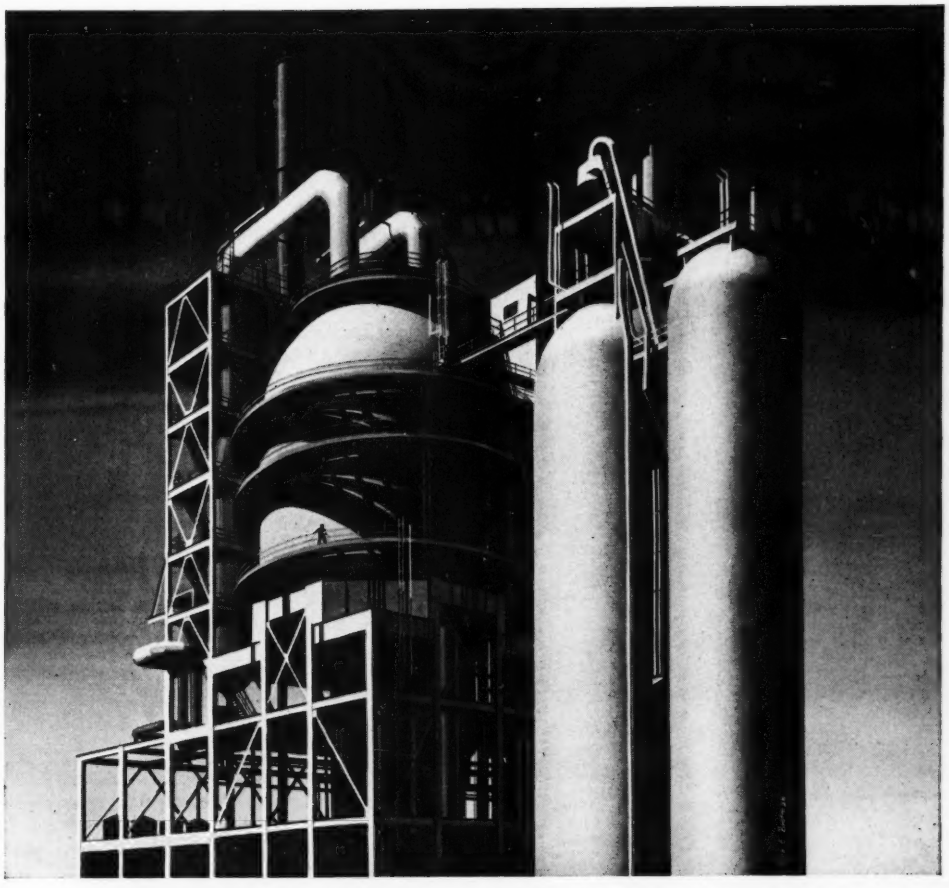
—*Courtesy Ford Motor Co.*

Air cooling is a feature of the new Ford automatic transmission, which will be available on Mercury and Ford cars later this year.

waves would not go over this hill or through it, the beam was reflected around it.

In operation the microwaves are beamed at a large aluminum reflector sheet placed some two miles from the sub-station. This sheet, which measures twenty feet square, is mounted on a 50-foot tower and is in the "line of sight" of both the sub-station and the generating plant. Microwaves striking this mirror-like reflector are deflected around the side of the mountain to the receiving apparatus.

This "bent" radio beam makes it possible for the load dispatcher at the sub-station to have direct control of activities at the generating plant in order to meet varying power requirements. The two way microwave installation operates either by voice or electrical impulses. Seven voice conversations can be sent simultaneously.



What's behind the world's champ "Cat Cracker"?

In October, 1949, this world's biggest catalytic cracking plant was put into operation at Linden, N. J., refining oil products for Esso Standard Oil Company.

This behemoth can produce 1,520,000 gallons of liquid power *every day*... that means more heat for homes, more fuel to operate factories and farms, more power to make the nation's wheels go 'round... better living for everybody.

It took a vast amount of scientific skill and achievement, of vision and daring, to build this huge processing plant and put it into operation. Scientific petroleum research and oil engineering progress have always been pioneered and encouraged at Esso.

With the chance to learn and advance on the job, along with fair pay and good working experience... the employees of Esso Standard Oil form a loyal and experienced team, that is constantly striving to improve the high quality and value of products that are sold at the famous Esso Sign from Maine to Louisiana.

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Bright New World

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But this is only the start of the plastic story. Plastics help make better clothing. Modern furniture and furnishings owe much to plastics. Much of your food is packaged in clean, clear plastics. Plastics add safety, durability, and appearance to many of your electrical appliances.

These versatile basic materials are man-made. Organic chemicals are the ingredients of the "unfinished" plastics—called resins. From these resins come the many different forms of plastics we know.

The people of Union Carbide are leaders in the production of plastics, resins, and related chemicals. They also provide hundreds of other materials for the use of science and industry.

FREE: *If you would like to know more about many of the things you use every day, send for the illustrated booklet "Products and Processes." It tells how science and industry use UCC's Alloys, Chemicals, Carbons, Gases, and Plastics. Write for free booklet C.*

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MORRIS TYPE R SLURRY PUMP

Simple impeller adjustment assures minimum lay-up time

● The design of the Morris Type R is simplicity itself. And simplicity in a pump means longer uninterrupted service . . . lower maintenance . . . better performance under tough operating conditions.

● To dismantle, you merely remove four bolts. Take off the end cover . . . and there's the impeller. *You don't have to disturb the piping.*

● Four adjusting screws close the worn clearances on the suction side of the impeller. This adjustment moves the entire rotating assembly as a unit, including impeller shaft, bearing and bearing housing.

● Since the Morris Type R takes its suction from the drive side only, the packing is subjected to suction or positive head pressures only. Stuffing box is not nearly as vulnerable to entrance of solids.

● Morris 83 years' experience in pump building is your best assurance of dependable service from the Type R Slurry Pump.

MORRIS MACHINE WORKS
Baldwinsville, N. Y.
Branch Offices in Principal Cities

MORRIS *Centrifugal Pumps*

Diesel Engines

(*Continued from page* 14)

effort to reduce fuel costs is the Dual-Fuel engine, a postwar development.

The Dual-Fuel engine is defined by the Diesel Engine Manufacturers Association as one which uses all oil fuel on the diesel cycle, or predominately gaseous fuel with oil ignition, and is fully and immediately convertible from one to the other. Two-stroke and four-stroke naturally aspirated and supercharged Dual-Fuel engines are available, and are gaining in use wherever gaseous fuel is available at a more favorable cost than diesel fuel. Such engines utilize a pilot injection of oil for ignition when operated upon gas. Pilot oil quantities approximate five per cent of the total energy input to the engine. Successful operation with sewage gas, refinery gas, natural gas, propane, and other gases has been experienced.

In areas or applications where the supply of gas is not dependable or consistent, the Dual-Fuel engine offers attractive possibilities. Such an application is the sewage plant. At the inception of a new plant, and during certain periods of operation, a sufficient supply of gas to carry full load on the engine may not be available. At such times, the engine governor can automatically make up the difference by increasing the quantity of oil injected. Other applications exist where Dual-Fuel convertibility is a factor of real importance in the selection of an engine. It may be safely predicted that a substantial number of Dual-Fuel engines will be produced by diesel manufacturers in the coming years.

Progress Continues

If diesel utilization is to continue its upward trend in face of the challenges offered by improvements and perfection of its chief competitors, the spark-ignition engine and the gas turbine, progress in its refinement must continue uninterrupted. The industry, aware of such challenges, is not content with today's product. In laboratories throughout the nation the relentless search for improvements proceeds.

THE DU PONT DIGEST

Chemical Research helped produce

Better Tires For You

The tires on your car right now may have cords of Cordura* High Tenacity Rayon yarn. If so, you benefit from one of the most important contributions that Du Pont scientists have made through the years to the automotive industry.

"Cordura" High Tenacity Rayon is comparable to structural steel in tensile strength. It makes possible tires that are at once lighter, stronger and safer than pre-war tires. Unlike natural fibers, the qualities of this product of chemical science are always uniform.

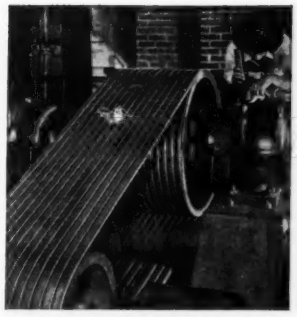
UNDIES TO TIRES

At first, rayon was used mainly in making articles of clothing. However, with an improved tire cord in mind, Du Pont scientists set out to produce a tougher rayon than any previously known. The problem was given to a skilled team whose members included organic, physical and analytical chemists, physicists, and chemical and mechanical engineers.

One of their first discoveries was that strength could be increased by using cotton linters as the source of cellulose, in place of wood pulp. It was found, also, that the viscose solution had to be prepared and handled with extreme care. Perhaps the most important lesson was one which the silkworm had taught centuries before: *stretching increases strength*. The Du Pont experimenters stretched the new yarn and made rayon with a tensile strength of about 70,000 pounds to the square inch—more than twice the strength of textile rayon then being produced.

TRIED AND PROVED

With the cooperation of tire manufacturers, "Cordura" was tested in heavy-duty tires on baking-hot desert roads. During the war it proved itself on command cars, trucks and jeeps. Today, rayon-cord tires are widely used on trucks and buses, and leading manufacturers use Du Pont "Cordura" in tires they make for passenger cars.



V-belts of "Cordura" and rubber keep even tension, far outlast others.

The combination of lightness and strength offered by "Cordura" has also earned it a welcome from makers of conveyor belts, V-belts and hose for domestic, agricultural and industrial uses. It is used to reinforce laminated kraft paper, to tie wires to electrical switchboards and as a chain warp in carpets to bind the wool tufts firmly in place. One of the newest uses is in plastic clotheslines. The Du Pont Company makes none of these articles. But because Du Pont scientists had an idea and the facilities and funds to develop it, many businesses can now offer you better products to make life safer and more enjoyable.

*REG. U. S. PAT. OFF.

SEND FOR "The Story of Cellulose," a 43-page, illustrated booklet that describes the making of viscose and acetate rayon, lacquers, plastics, coated fabrics, etc. Many charts and equations. For free copy, write to the Du Pont Company, 2503 Nemours Building, Wilmington, Delaware.

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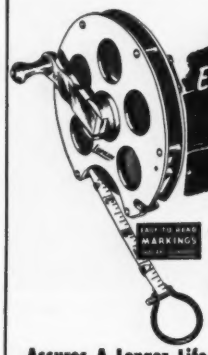

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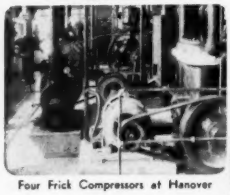

Four Frick Compressors at Hanover

The W. E. Bittinger Co. freezes cut sweet corn and corn-on-the-cob, as well as spinach, at its new plant in Hanover, Penna. Its Frick-Freezer handles 30,000 pounds of corn a day; its storages hold 400,000 pounds.

Another example of the effectiveness of Frick low-temperature refrigeration — used also in the world's largest quick-freezing plant.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

FRICK CO.

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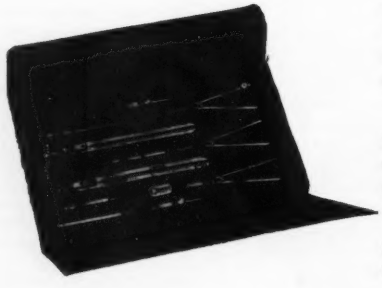
Attention Frosh Engineers



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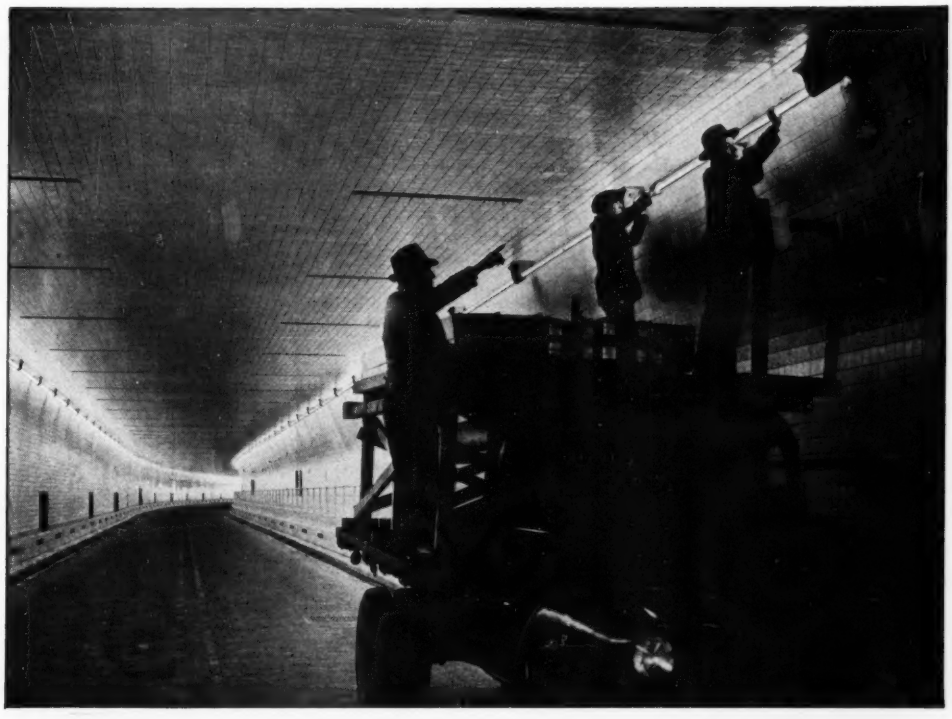


Why they put a glass pipe line underneath Buttermilk Channel

If you've ever driven through a long tunnel, you know how hard the lights are on your eyes.

The reason is you pass under a succession of bright spots of light which are apt to take your attention from the road. And you're made uncomfortable by the reflection of these bright spots from the top of the car ahead.

But New York's new 9117-foot Brooklyn-Battery Tunnel—America's longest, built and operated by the Triborough Bridge and Tunnel Authority—has an amazingly different and better kind of tunnel lighting.

Instead of the disturbing flicker of lights placed at regular intervals, motorists enjoy bright and even illumination—practically daylight—every foot of the way beneath Buttermilk Channel and New York Harbor.

The pipe line for this flood of light is built of 3000 twelve-foot sections of Corning's Pyrex brand glass tubing. Each length of pipe is a self-contained light cartridge, with two slim fluorescent lamps inside.

Should one of the lamps die out, that cartridge is replaced with another, assembled and kept ready on a repair truck. And replacement is made as easily as you'd pop a new bulb into a light fixture in your home.

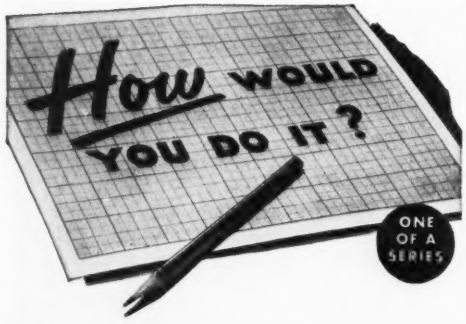
The twelve-foot sections of Pyrex pipe are only two inches in diameter, with walls only a quarter of an inch thick. But despite their slimness, they're so strong they can withstand washing with a high-pressure hose. They're so sturdy they're not injured by truck tarpaulins which sometimes work loose and slap against them.

Designers of this new tunnel lighting system had no trouble finding a material needed to make it work because, years ago, Corning developed heat-resistant Pyrex pipe for industrial use.

Throughout industry, *Corning means research in glass*—research that has helped make glass a material of practically limitless uses.

So, when you're out of college and busy planning new products or processes, or improvements in existing ones, it will pay you to keep glass in mind. Then we hope you will call on Corning before your planning reaches the blueprint stage. *Corning Glass Works, Corning, New York.*

CORNING
means research in glass



PROBLEM—You are designing a cabinet-type oil heater. The oil and air metering valve has to be placed at the bottom. You now want to provide a manual control for the valve located on the cabinet front where it is easy to see and to operate. How would you do it?

THE SIMPLE ANSWER—Use an S.S.White remote control flexible shaft to connect the dial to the valve or to a rod running to the valve. The latter method was used in the heater illustrated below. The flexible shaft will provide smooth, sensitive control and will allow you to put the dial anywhere you want it.

Photo courtesy of Quaker Mfg. Co., Chicago, Ill.

★ ★ ★

This is just one of hundreds of power drive and remote control problems to which S.S.White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.

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WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

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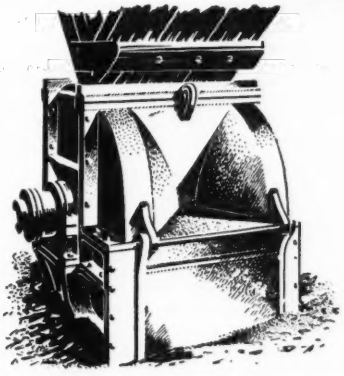
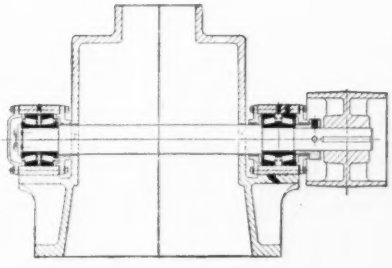


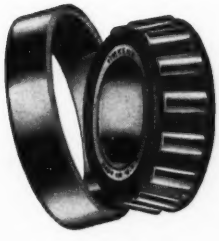
How to improve a wood hog's appetite

The wood hog shown here chews up logs for paper pulp like a giant pencil sharpener. As they chip away at the logs, the revolving cutter knives impose heavy shock loads on the bearings. To carry these shock loads, engineers specified that the cutter shaft be mounted on Timken® tapered roller bearings. Due to the line contact between the rolls and races, Timken bearings have extra load carrying capacity —take the heaviest shock loads.

Here's how engineers use TIMKEN® bearings for heavy shock loads

To give extra support to the wood hog's main shaft, double-row Timken bearings are used. The tapered construction of the rolls and races enables Timken bearings to carry both radial and thrust loads in any combination. Shafts are held in rigid alignment, end movement eliminated. Because Timken bearings permit the use of effective closures, lubricant stays in and dirt and moisture are kept out.





TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about TIMKEN® bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◐ AND THRUST —◐— LOADS OR ANY COMBINATION ✳

STRESS and STRAIN...

A man went to the bar and ordered a Martini, drank it, chewed up the bowl of the glass and threw the stem over his shoulder. He continued this for six Martinis and noticed that the bartender was staring at him.

"I guess you think I'm crazy, don't you?" he asked.

"I sure do," the bartender replied, "the stems are the best part."

* * *

"Last night my girl finally said 'yes'."

"Good, when's the wedding?"

"Wedding? What wedding?"

* * *

The motor of the car pounded, sputtered, and finally stopped.

"I wonder," mused the young man, "what that knock was."

"Maybe," said the pretty girlfriend, "it was opportunity."

* * *

Poor little handkerchief, don't you cry;
You'll be a bathing suit bye and bye.

* * *

Coroner: "And what were your husband's last words?"

Widow: "He said: 'I don't see how they can make any profit on this stuff at a dollar a quart'."

* * *

And then there is the one about the pilot that came into the passenger compartment of the plane and said, "We're lost, but we're making good time."

First Architect: "Jackson fell off his stool with a quart of beer."

Second Architect: "Did he spill any?"

First Architect: "No, he managed to keep his mouth shut."

* * *

Jack had been informed by his father that he was spending twice as much money at college as he should. "Son," remarked the father, "I know you're spending it on whiskey and women. I don't mind your fooling with one of these, but you can't keep up the pace with both. You've got to cut one of them out absolutely." "All right, Dad, I'm willing. Which one would you advise me to cut out?" The old man thought in silence for a minute and then said, "Son, you can drink all the whiskey you want when you get old."

* * *

A lunatic was leaning out of the asylum and watching the gardener.

"What are you doing?" he asked.

"I'm putting manure on the strawberries," the gardener said.

"I usually put sugar on them," replied the lunatic, "but then I'm crazy."

* * *

Coed: "In the same circumstances, how would you have played the hand?"

Bridge Expert: "Under an assumed name, ma'am."

* * *

The sweet young coed was out on her first college date. She was trying hard to appear worldly and sophisticated. After the movie, her escort took her for some refreshments. "Two beers," he told the waiter. "I'll have the same," she murmured."

Prosecuting Attorney: "You mean to say you had sixteen beers and didn't move once from the table the night of the murder?"

* * *

Hubby sneaked home at 3 a.m. His angry wife met him at the door. "So home is the best place after all!" she snorted.

"I don't know about that," her mate replied, "but it's the only place open."

* * *

Coed: 'I had to change my seat several times at the movie last night."

Room-mate: "My goodness, did some fellow get fresh with you?"

Coed: "Finally."

* * *

The little boy sat disconsolately on the curb and sobbed as though his heart were breaking. The kind old lady stopped and asked sweetly, "Is a itta boy cwyin'? Tum, tella nice wady wassa matter."

"If you are inquiring as to the cause of my lachrymose condition," he answered, looking at her pityingly, "it is because I have been unable to find any suitably intelligent playmates whose eugenic constitutions are in harmony with my pathological tendencies and whose hereditary affiliations meet with the approval of my parental relations since we moved to this damned place from Boston."

* * *

Now that you have finished the educational matter on this page, why don't you go to the front and read the rest of the magazine?

Photography can make this page

this small

IT'S DONE WITH MICROFILM MAGIC

TINY AS IT IS, the little rectangle above is this page in black and white—as it appears on microfilm. Everything there, condensed to a mere spot, but ready to be brought back full size with all its features intact. For photography can reduce tremendously without losing a detail.

As a business or professional man, you can utilize photography's reducing ability in any of many important ways.

You can utilize it to save space . . . to speed reference. With Recordak microfilming, you can "debulk" files 99% . . . keep the records at hand for quick viewing, full size, in a Recordak Reader.

You can utilize photography to make sales presentations more complete, more resultful. With motion pictures, you can "pack" a plow, a plant, a whole process into a small can of film . . . travel it where you will, show it off "large as life" and much more dramatically.

Only a suggestion . . . this . . . of what photography can do because it is able to condense. And because it has many other unique characteristics as well, photography is becoming an increasingly important tool all through science, business, and manufacturing.

Whenever you want to improve methods of recording, measuring, testing, teaching, or countless other functions, be sure to consider the unusual abilities and advantages of photography.

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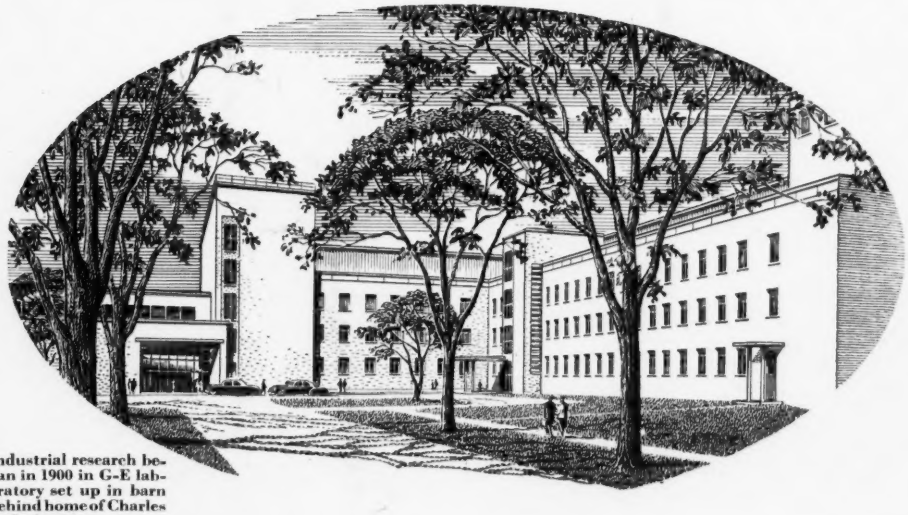

Industrial research began in 1900 in G-E laboratory set up in barn behind home of Charles P. Steinmetz.

When the General Electric Research Laboratory was established in 1900, it was the first industrial laboratory devoted to fundamental research.

At that time E. W. Rice, Jr., then vice president of General Electric, said:

Although our engineers have always been liberally supplied with every facility for the development of new and original designs and improvements of existing standards, it has been deemed wise during the past year to establish a laboratory to be devoted exclusively to original research. It is hoped by this means that many profitable fields may be discovered.

Many profitable fields *were* discovered—profitable not only for General Electric but also for industry, the American public, and the world.

A half century ago the industrial experimental laboratory was itself an experiment. This month it begins its second half century with the dedication of a new building, greatly augmenting the facilities it offers to the advancement of man's knowledge.

You can put your confidence in—

GENERAL ELECTRIC